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PUBLIC NOTICES.

Royal Air Force.

VACANCY FOR CIVILIAN TECHNICAL OFFICER AT ELECTRICAL AND WIRELESS SCHOOL, CRANWELL.

An ELECTRICAL ENGINEER is REQUIRED on or about the 1st April next, to act as Lecturer and Instructor at the Royal Air Force Electrical and Wireless School, Cranwell. Applicants, who should preferably have had some previous lecturing experience, must possess practical knowledge of alternating current work and its application to high-frequency engineering, and an electrical engineering degree or its equivalent is essential.

The post will be graded as a civilian technical officer appointment on the salary scale £250 by 15 by £350 plus Civil Service bonus, which, with bonus at the present rate, amounts to a salary range of roughly £329 to £447.

Applications should reach the SECRETARY, Air Ministry (S.2) not later than 27th February, and selected candidates will be required to attend for interview on or about the 10th March. Preference will be given to applications from retired or reserve R.A.F. officers. 8137

The Government of

INDIA invite APPLICATIONS for an APPOINTMENT as ASSISTANT AIRCRAFT INSPECTOR. Pay Rupees 900, rising by annual increments of Rs. 50 to Rs. 1000 a calendar month (less 10 per cent. temporary emergency cut). Three years' agreement. First-class passage to India and back. Strict medical examination.

Further particulars and forms of application may be obtained upon request by postcard from the HIGH COMMISSIONER FOR INDIA, General Department, India House, Aldwych, London, W.C. 2. Last date for receipt of applications 25th February, 1932. 8145

University of London.

A COURSE of TWO LECTURES, with lantern illustrations, on "PHYSICAL LINES OF ELECTRIC FORCES AND THEIR APPLICATION TO THE INTERPRETATION OF THE ELECTRO-MAGNETIC FIELD," will be given by SIR JOSEPH J. THOMSON, O.M., F.R.S. (Master of Trinity College, Cambridge), at UNIVERSITY COLLEGE, LONDON (Gower-street, W.C. 1), on THURSDAYS, FEBRUARY 18th and 25th, at 5.30 p.m. At the First Lecture the chair will be taken by Professor G. P. Thomson, F.R.S. (Professor of Physics in the University).

ADMISSION FREE, WITHOUT TICKET.

S. J. WORSLEY, Academic Registrar.

8103

Coventry Local Education AUTHORITY.

TECHNICAL COLLEGE.

PRINCIPAL: D. R. MACLACHLAN, B.Sc., A.M. Inst. M.E.

APPLICATIONS are INVITED for the APPOINTMENT of HEAD of the MECHANICAL ENGINEERING DEPARTMENT.

Salary £450 per annum, rising by annual increments of £25 to £600 per annum, less 10 per cent. reduction.

Form of application, which must be returned duly completed by 3rd March, 1932, and particulars of appointment, may be obtained from the undersigned on receipt of a stamped addressed foolscap envelope.

FRANK H. HARROD, Director of Education.

Council House, Coventry. 8139

London County Council.

PRINCIPAL of Westminster Technical Institute, Vincent-square, S.W. 1, REQUIRED in September. The activities of the Institute include: (1) a School of Art, Day and Evening Classes; (2) a Junior Technical Day School of Cookery and Waiting for Training Boys as Chefs and Professional Waiters; (3) Evening Classes in Civil and Structural Engineering; Architecture, Surveying and Valuations; Gas Engineering and Supply (a special feature of the Institute is the large Classes in Gas Engineering and Supply); (4) Evening Classes in Advanced Cookery for Men and Women. Salary scale £850-£50-£1000, less 10 per cent.

Apply, EDUCATION OFFICER (T.1), County Hall, Westminster Bridge, S.E.1 (stamped addressed foolscap envelope necessary), for particulars and form, to be returned by 29th February. Canvassing disqualifies. 8144

Borough of Stockton-on-Tees.

RE-SEWERING OF THE LUSTRUM BECK AREA.

Firms having experience in the construction of schemes of sewerage are invited to send in their names to Mr. J. P. Wakeford, M.I.C.E., Borough Engineer, Victoria Buildings, Stockton-on-Tees, together with a deposit of £5 (Five Pounds), when copies of the general conditions of contract, specification, bill of quantities, and form of Tender for the CONSTRUCTION of approximately FOUR MILES of SEWER will be forwarded.

The deposit will be refunded on receipt of a bona fide Tender.

TENDERS are INVITED in TWO TYPES of CONSTRUCTION, viz.:—

(1) In situ Concrete Construction.

(2) Bitumen-lined Steel Pipe Construction.

Contractors will be at liberty to Tender for either (1) or (2) or both.

The contract will include:—

Approximately 1139 Yards of 48in. diam. Circular Sewer.

Approximately 2330 Yards of 42in. by 68in. diam. Egg-shaped Sewer.

Approximately 372 Yards of 38in. by 57in. diam. Egg-shaped Sewer.

Approximately 1150 Yards of 30in. by 54in. diam. Egg-shaped Sewer.

Approximately 1079 Yards of 34in. by 51in. diam. Egg-shaped Sewer.

Approximately 791 Yards of 32in. by 48in. diam. Egg-shaped Sewer.

An Engineering Assistant will be in attendance on the 18th and 19th instant to conduct intending tenderers over the site of the works and to view trial holes, &c. Plans and details may be inspected at the Borough Engineer's Office.

Sealed Tenders, endorsed "Main Trunk Sewer," to be delivered at my office not later than 10 a.m. on the 2nd proximo.

The Corporation do not bind themselves to accept the lowest or any Tender.

THOS. DOWNEY, Town Clerk.

Borough Hall, 8th February, 1932. 8131

SITUATIONS OPEN.

BOX NO. 7998.—APPLICANTS Are ADVISED That this POSITION has now been FILLED. 8127 A

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE
ARRANGED FOR CARD INDEXING.

Erosion of Steam Turbine Blades. No. II. (P. 174)
(F. W. GARDNER.) THE ENGINEER, 12 - 2 - 32.

New Railway Bridge over the North Circular Road. (P. 178)
THE ENGINEER, 12 - 2 - 32.

Air Pollution in 1930-31. (P. 176)
(J. B. C. KERSHAW.) THE ENGINEER, 12 - 2 - 32.

Mechanism of Electric Locomotives. No. II. (P. 182)
(J. D. TWINBERROW.) THE ENGINEER, 12 - 2 - 32.

Telephone Progress in the London Area. (P. 184)
THE ENGINEER, 12 - 2 - 32.

Ball Bearing Manufacture. (P. 181)
THE ENGINEER, 12 - 2 - 32.

Markets for Internal Combustion Engines. (P. 190)
THE ENGINEER, 12 - 2 - 32.

Borehole Pumping Plant. (P. 194)
THE ENGINEER, 12 - 2 - 32.

INDEX TO ADVERTISEMENTS, PAGE 59.

PUBLIC NOTICES.

Borough of Swindon.

WATERWORKS.
LATTON WATER SCHEME.
CONTRACT NO. 7.
NEW OVERTOWN RESERVOIR.

The Corporation invite from experienced Contractors TENDERS for the CONSTRUCTION of a REINFORCED CONCRETE RESERVOIR of about one million gallons capacity with AUXILIARY WORKS.

The general conditions of contract, specification, schedule of prices and form of Tender, prepared by the Engineer, Dr. Herbert Lapworth, M. Inst. C.E., 25, Victoria-street, Westminster, S.W. 1, may now be obtained from the undersigned on payment of a cheque of £5 made payable to the Swindon Corporation, which amount will be returned on receipt of a bona fide Tender.

Facilities for seeing the drawings and inspecting the site and general information can be obtained on application from Mr. J. B. L. Thompson, M.C., Assoc. M. Inst. C.E., Borough Surveyor and Water Engineer, 24, Regent-circus, Swindon.

Sealed Tenders, endorsed "Tender for Latton Water Scheme, Contract No. 7," to be sent to the undersigned and received not later than Noon on Wednesday, 9th March, 1932.

The general conditions of contract will contain special conditions laid down by the Unemployment Grants Committee, including stipulations that (1) not less than 90 per cent. of the men employed on the work shall be obtained through the Employment Exchange or, as to a proportion in certain circumstances, by arrangement with the Poor Law Authorities; (2) 33 1/3 per cent. of the men employed on the work will be drawn from areas selected by the Ministry of Labour, other than the local area; (3) not less than 75 per cent. of the men taken on for the work must be ex-Service men.

The Corporation do not bind themselves to accept the lowest or any Tender.

W. H. BENTLEY, Town Clerk.

Town Hall, Swindon, 5th February, 1932. 8126

The Engineers' Register of

the JUNIOR INSTITUTION OF ENGINEERS, 39, VICTORIA-STREET, S.W. 1, licensed annually by the London County Council, contains the names and specialised experience of many Members, both Junior and Senior Men, who are available for service in administrative and technical capacities in all branches of engineering.

Employers seeking such men for service, either in Great Britain or abroad, are invited to address their inquiries to the SECRETARY. P1920

PUBLIC NOTICES.

Gainsborough Urban District COUNCIL.

NEW BORING AT THE WATERWORKS.

The above Council invite TENDERS from experienced Well Boring Contractors for the PUTTING DOWN of a BORING through the Red Marl into the New Red Sandstone Formation to a depth of about 1700ft., LINING it with 36in., 30in., 27in., and 24in. internal diameter STEEL TUBES, and PROVIDING the necessary PUMPING PLANT for testing its yield.

Copies of the specification and bills of quantities can be obtained from Mr. W. Vaux Graham, M. Inst. C.E., 5, Queen Anne's-gate, Westminster, upon depositing the sum of Five Pounds, which will be returned upon receipt of a bona fide Tender.

Sealed Tenders, marked "Tender for New Boring," must be received by the undersigned not later than first post on Monday, February 22nd, 1932.

The Council does not bind itself to accept the lowest or any Tender.

ERIC R. MORGAN, Clerk to the Council.

Council Offices, Gainsborough, 5th February, 1932. 8132

The Madras and Southern

MAHRATTA RAILWAY COMPANY, Limited, invite TENDERS for 5 LOCOMOTIVE ENGINES and TENDERS, 4-6-2 (Y.B.) Type.

Tenders are due in on TUESDAY, 8th March, 1932, by 2 p.m. Tender forms obtainable at address below, FEE ONE GUINEA, which is not returnable.

The Directors do not bind themselves to accept the lowest or any Tender.

Companies Offices:—25, Buckingham Palace-road, Westminster, S.W. 1. 8156

City of Leicester.

APPOINTMENT OF TRACING CLERK.

APPLICATIONS are INVITED for the APPOINTMENT of a TRACING CLERK (Male), age not to exceed 45 years. Must be a neat and expeditious tracer. Salary £200, rising by annual increments of £12 10s. (subject to satisfactory service) to £250 per annum, in accordance with Grade "C" of the Council's Grading Scheme. The position is an established post under the Local Government and Other Officers' Superannuation Act, 1922, and the successful candidate will be required to pass a medical examination and to contribute to the fund.

Applications to be made on forms to be obtained from the undersigned, accompanied by copies of three testimonials, and must be delivered not later than Monday, February 22nd, 1932.

A. T. GOOSEMAN, M. Inst. C.E., City Engineer and Surveyor.

Town Hall, Leicester, February, 1932. 8128

PUBLIC NOTICES.

NOTICE TO FOREMEN.

The National Foremen's Asso-

CIATION is an Association of Foremen formed to represent them on all questions affecting their supervisory interests.

For full particulars apply GENERAL SECRETARY, 95, Belgrave-road, Westminster, S.W. 1. 7968

SITUATIONS OPEN.

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN THIS CLASSIFICATION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge and co-operation is asked for.

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JUNIOR ASSISTANT ENGINEER REQUIRED for Large Manufacturing Plant.—Address, stating training, experience, age, and salary expected, 8143, The Engineer Office. 8143 A

METALLURGIST REQUIRED, as WORKS MANAGER. Must be experienced in economical production of Non-ferrous Alloys. Details of experience, age, salary desired.—Address, P2035, The Engineer Office. P2035 A

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Address, stating salary required, experience and references, 8154, The Engineer Office. 8154 A

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Only experienced applicants will be considered.

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WORKS MANAGER for Company Manufacturing Car and Commercial Radiators. Must have expert knowledge, capable of organising production. Strict disciplinarian. State age, experience, and qualifications. Unsuitable applicants not considered. —Write, Box D178, T. B. Browne's Advertising Offices, 163, Queen Victoria-street, London, E.C. 4. 8133 A

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SITUATIONS WANTED, Page 2.
AUCTIONS, Page 60.
PATENTS, Page 2.
PARTNERSHIPS, Page 2.
EDUCATIONAL, Page 2.
FOR HIRE, Page 60.
BUSINESSES and PREMISES (For Sale, etc.), Page 60.
AGENCIES, Page 2.
MACHINERY, &c., WANTED, Page 2.
MISCELLANEOUS, Page 2.
FOR SALE, Pages 2, 4 and 60.
WORK WANTED, Page 60.
PUBLISHERS' NOTICES, Pages 3 and 60.

For Advertisement Rates see First Column Overleaf.

The Engineer

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P2013 I

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16	0	11	9	180
15	6	11	6	180
15	6	11	0	180
14	0	12	0	180
12	6	10	6	150
14	6	10	9	160
12	10	9	6	140
15	0	11	6	120
13	3	10	9	125
6	6	6	6	110
6	9	9	0	80

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For continuation of For Sale Advertisements see page 4.

A Seven-Day Journal

British Electrical Research.

THE eleventh Annual Report of the British Electrical and Allied Industries Research Association shows that, owing to the more adequate financial support that was received during the period reviewed, the work of the Association was accelerated. In the early years of the Association's work the funds were provided almost entirely by the manufacturers, but gradually the true value of research to other branches of the industry became recognised and the supply authorities took an increasing share in the necessary finance. The Government also came forward with very material assistance, with the net result that during the past year an income of approximately £50,000 was received. But, although this sum has enabled a more extended programme to be undertaken, it should be noted, the Report states, that in comparison with the sums of money spent by large research associations, and particularly those in America and Germany, even £50,000 is little more than negligible. Sums of about £16,000 subscribed by the manufacturers' section and users' section, and by the Department of Scientific and Industrial Research were augmented by £1000 received from the Institution of Electrical Engineers, and smaller sums from other sources. A contribution of £500 per annum guaranteed for two years by the Electric Lamp Manufacturers' Association was a welcome addition to the list of subscriptions. Many large and small authorised undertakers are now contributing the necessary sums to qualify them for ordinary membership, but several large undertakers are not yet bearing their proportional share. While, with the income available, the Association has been able to bring into activity several researches previously deferred, and to begin work in other directions, the field of profitable work in co-operative research has not by any means been fully covered, and there are still many avenues of profitable development quite beyond the Association's present means.

Salving the M 2.

FOLLOWING the finding of the sunken submarine "M 2," in the West Bay off Portland Bill, diving operations revealed that the hangar door and the upper conning tower hatch were open, but that the engine-room hatch and the forward hatch were both closed. It was also conclusively proved that the vessel was flooded from stem to stern. Mr. E. F. Cox, of Cox and Danks, Ltd., has been entrusted with the salvage work. On his arrival at Portland on Saturday last, he explained to the divers and salvage crew on "H.M.S. Tidworth" his plans for raising the submarine, which included the removal of the seaplane from the hangar and the sealing up of all openings with quick-setting cement, so that the ship could be lightened by blowing in compressed air, and when made buoyant be towed to Portland for dry-docking. On Monday last, February 8th, the seaplane was successfully brought to the surface, and was towed into Portland Harbour by one of the "P" boats. The work was rendered particularly difficult on account of the strong currents and the danger of the wire struts getting in the way of the divers engaged in the underwater operations. An effort will now be made to close the hangar door and to render the hull generally water-tight with a view to expelling the water from the hull by compressed air. The arrival of bad weather has stopped operations, and it is probable that the raising of the vessel will be postponed for some months.

A New Telephone Building in London.

ON Wednesday last the Lord Mayor of London, accompanied by the Bishop of London and the Postmaster-General, laid in Queen Victoria-street the foundation-stone of what will probably be the largest telephone building in this country. When it is complete it will form part of the telephone switching centre of the world, and it will be linked by bridges with the great trunk exchange in Carter-lane. The girls who work the switches will speak French, German, Italian, and other languages. Every kind of call, from the local subscriber to the £2 per minute round the world speaker, will be dealt with. The development of the telephone in this country and the Continental and wireless services necessitated the enlargement of the existing building in Carter-lane, and the new building will be used to house two new automatic telephone exchanges serving an important part of the City of London, mechanical switching equipment for long-distance telephone services, and a large quantity of machinery.

The Pneumatic-Tired Rail Coach.

DURING the present week a number of demonstration runs have been made with a pneumatic-tired rail coach, similar to that described and illustrated in our issue of September 12th last year. It will be remembered that this coach was developed by Messrs. Michelin et Cie., of Clermont-Ferrand, France, for use on branch lines in place of steam traction, and that it is propelled by a 27 H.P. petrol engine. Special Michelin tires are fitted. Owing to the fact that the tires must have a very narrow tread to fit the rails, it is not possible to carry any great weight on each wheel, and in consequence the vehicle has five axles. No loss of adhesion, however, occurs, since the coefficient of friction between rubber and steel is greater than that of steel on steel. Last Tuesday we had the opportunity to attend a demonstration run between Bletchley and Oxford, and we were much impressed by the silent running of the vehicle. From a standing start, it gained a speed of 52 miles per hour in one minute and on several occasions reached a velocity of 60 miles per hour during the run. As an illustration of its capabilities, the run from Bletchley to Oxford was made as a stopping train, the coach demonstrating that it was capable of maintaining a substantially more rapid service than a steam-operated train. The return journey was completed as an express, the speed seldom falling below 50 miles per hour, except when passing through stations at which a 40 miles per hour speed limit prevailed. The passengers had an opportunity to examine the coach at Oxford, when particular interest was shown in the arrangement by which, should the pressure in one of the tires fall by 15 lb. per square inch below the normal of 85 lb. per square inch, a klaxon horn is operated in the driver's cabin. The car has a capacity for carrying twenty-four passengers and weighs, empty, 5 tons. It is claimed for it that it renders possible the economical operation of secondary railway lines.

Central Control of Transport.

IN a paper on "Road Finance in relation to General Transport Finance," read before the Institute of Transport on Monday last, Messrs. Alfred Hacking and Rees Jeffreys state that no student of the financial aspect of transport could in these difficult days ignore the mutual problems of Great Britain and every part of the British Commonwealth of Nations. There was only one foundation upon which the structure of British commerce could be built in the light of the present and future world conditions, and that lay in a full and complete realisation that the basis of British political and economic policy must from now onwards be built on Imperial co-operation and development. The supreme Government should confine the exercise of its power in transport to the appointment and dismissal of a Transport Commissioner or Commissioners, and the control of foreign borrowing. When such Commissioners had been appointed, they should be free from interference of the political Government, and their dismissal be dependent on failure to achieve satisfactory results. The Commissioners should be men of proved organising and financial abilities, and with transport experience. They should be able to visualise the needs of transport from a business and not a political aspect, and exercise the ordinary facilities of raising capital in one form or another for capital purposes. As business people, they would, of necessity, consider the rates of licence fees on road transport from a very different angle to that associated with Parliament or the Exchequer. The revenues or loans raised by the Commission would be applied from time to time, and under such conditions as circumstances might warrant, for the improvement of such means of transport as, in their judgment, would be most likely to give the maximum of efficiency and economy. In effect, the Commission would take over the Ministry of Transport staff, Area Commissioners, &c. The Commissioners would not be owners of any transport undertaking, but their activities would rather be in the nature of those of a financial and administrative chartered company directed by Parliament to employ its funds, whether of capital or revenues, to certain definite trading purposes. The scheme visualised a co-ordinating administration capable of adoption by Dominion Governments, all of whom, as owners of railway systems, were placing every obstacle in the path of road development.

Structural Steel in Buildings.

ON Tuesday last a part of the proposed new code of practice for the use of structural steel and other materials in buildings came before the London County Council. The report of the Advisory Committee on the amendment of the London Building Act of 1930 states that it will be impossible to complete the work sufficiently early to enable it to submit a complete report to the Council in time to allow an amending Bill to be promoted in the parliamentary session of 1932–33, but it has completed its consideration of the third schedule to the Act. This schedule consists of the provisions originally contained in the London County Council (General Powers) Act, 1909, for the regulation of the erection of buildings of metal skeleton construction. Time has shown, however, that these provisions, which were based on relatively little practical experience, are unnecessarily stringent in certain respects, and there is a strong demand for their reconsideration. The Committee has therefore drafted a new code, based on the findings of the Department of Scientific and Industrial Research, and, in general, accord with the proposed British Standard Specification. The adoption of the code, it is stated, would facilitate the work of design and construction, and would reduce building costs. It would also greatly relieve the Council's officers of the responsibility of checking designs when application is made to the Council to exercise the power of waiver or modification of the requirements of the schedule, given to it by Sec. 58 of the London Building Act, 1930. In view of the length of time that must elapse before the passing of an amending Bill, the Committee suggests that the Council might adopt the new code as the basis of its consideration of applications for relief from the requirements of the schedule now in force.

Work on the French Liners.

As a result of the interview of the French Prime Minister, Monsieur Laval, and the Minister of Merchant Marine, Monsieur de Chappedelaine, with the Finance Committee of the Senate, it was agreed at the end of last week to extend a credit of 110 million francs, or about £130,000 at the present exchange rate, to the Compagnie Générale Transatlantique, in order to enable it to meet its financial obligations over the next six months. As a result of this decision, work was resumed on the "Champlain" and "T 6," the super "Ile de France," on Monday morning last at the St. Nazaire yard of the Penhoët Company. In view of some statements which have been made attributing the difficulties of the French Line partly to the excessive profits made by the Penhoët Company on orders of which they were supposed to have a monopoly, Monsieur René Fould, the chairman of the company, has made an official statement of the facts, in which he recalls that out of twenty-three C.G.T. ships ordered since the war, only five, representing one-third of the total tonnage, were constructed at the Penhoët yard. Further, between the years 1921 and 1930 the C.G.T. orders only represented one-third of the shipbuilding operations of the firm. The prices paid were always the lowest ruling in the international market, and in the case of the largest liners, no other berths in French yards were suitable. The average dividends paid during the last ten years have not exceeded 3·7 per cent., while the management charges have been less than half those prevailing before the war.

A New Nile Bridge.

ON Thursday, February 4th, the foundation-stone of the new Kasr-el-Nil Bridge, which will join Cairo to the residential quarter on Gezira Island, was formally laid by King Fuad. A silver casket with an engraving of the complete bridge was presented to the King by Mr. C. Mitchell, of Dorman, Long and Co., Ltd., of Middlesbrough and London, who are carrying out the work. It is expected that the new bridge will be called after the Khedive Ismail, instead of bearing the name Kasr-el-Nil, the next bridge downstream, now called the Bulak Bridge, being named after King Fuad. Work on the bridge was begun in April, 1931, and will be completed in June next year. As designed, it has six spans and one double swing span, which, when open, provides two 66ft. wide channels for river craft. The piers and abutments are of granite, which is quarried near Aswan, and over 4000 tons of British steel will be used. The total length of the bridge is about 1250ft., and it has a width of 66ft. The superstructure will comprise four lines of steel girders forming the main roadway, while there will be footpaths on either side, carried on cantilevers supported from the outer main girders. Special consideration, we understand, has been given to the architectural effects, and on each side of the Nile paved terraces will be formed with ornamental staircases leading from the roadway above. The cost of the bridge will be about £300,000.

British Electrical Manufacturers and the Argentine.

AN important step towards the furtherance of British trade with the Argentine has recently been taken by the electrical industry through the BEAMA. It has been decided to appoint a representative of the industry who will reside in the Argentine, with headquarters in Buenos Aires. The representative will act in a consultative and liaison capacity in directions likely to assist the interests of British electrical manufacturers, and with a view to augmenting the efforts made through existing channels by British firms. Mr. V. Watlington, chairman of the Council of the BEAMA, has been actively and constructively interested in initiating the plans for the establishment of permanent representation in the Argentine on the part of the electrical industry ever since his return from the Buenos Aires Exhibition. The principal functions of the representative will be to maintain contact with Government Departments, public utility companies, railway companies, engineering institutions, &c., and between agents and representatives of the manufacturers, in order to facilitate consultation when required with the direction and control of the Committee at home, and with the recognition and support of the Department of Overseas Trade. The BEAMA Argentine Committee has selected as the resident Argentine representative Mr. H. C. Siddeley, M.I.E.E., who represented the Association at the British Empire Trade Exhibition last year.

The Erosion of Steam Turbine Blades.

By F. W. GARDNER, B.A., A.M. Inst. C.E.

No. II.*

THE MAGNITUDE OF THE FORCES INVOLVED.

THE problem of calculating the stresses produced in a plate by the impact of a drop of fluid is not one that lends itself to any simple mathematical solution, and there appear to be very few data available on the subject. Only by applying the theoretical mechanics of the closely related problem of the collision of elastic solids, and making certain assumptions, is it possible to form any conclusions as to the actual magnitude of the pressures produced in the

FIG. 5—TUNGSTEN STEEL

case of fluid impact. By this method, which will be discussed more fully in the last article of this series, an equation can be deduced which expresses in a simple form the relation between the velocity of impact and the pressure which it produces. The equation shows that the pressure is proportional to the first power of the velocity and that it does not depend on the size of the drops. As regards the actual magnitude of the forces it leads to the conclusion that the pressure resulting from direct impact at 1000ft. per second will be of the order of 40 tons per square inch.

Before passing on to a comparison of this estimate with the conclusions to be drawn from the experimental evidence at the author's disposal, it will be well to consider the possibility of pressures pro-

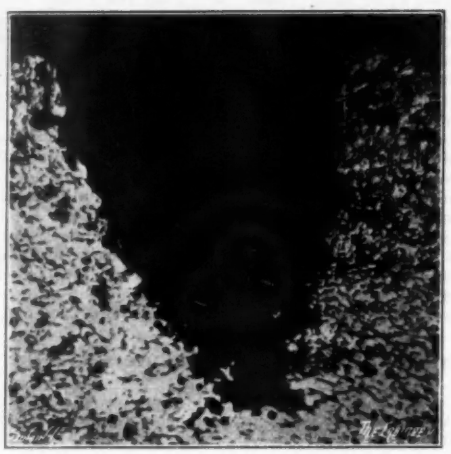


FIG. 6—PIT IN AUSTENITIC STEEL

duced in some other way, attaining values much in excess of those which can result from direct impact.

It is well known that extremely high pressures may be produced by the water hammer action of cavitation, a phenomenon that involves a sudden collapse of a vacuous cavity in a fluid medium. The question of cavitation was fully investigated in 1918 by a committee of the Board of Invention and Research, under the chairmanship of the late Sir Charles Parsons. Some results of their investigations were given in a paper to the Institution of Naval Architects in April, 1919. In that paper it was shown that the intensity of pressure that is produced by the collapse of a spherical cavity depends on the ratio of the initial volume of the cavity to the volume of the nucleus on which it collapses. If therefore a drop were to strike a blade which had surface irregularities in such a manner that a vacuous cavity was enclosed and this cavity were then to collapse, pressures of a much higher order than those attributable to direct impact could result, provided the volume of the nucleus were small enough compared with the original size of the cavity.

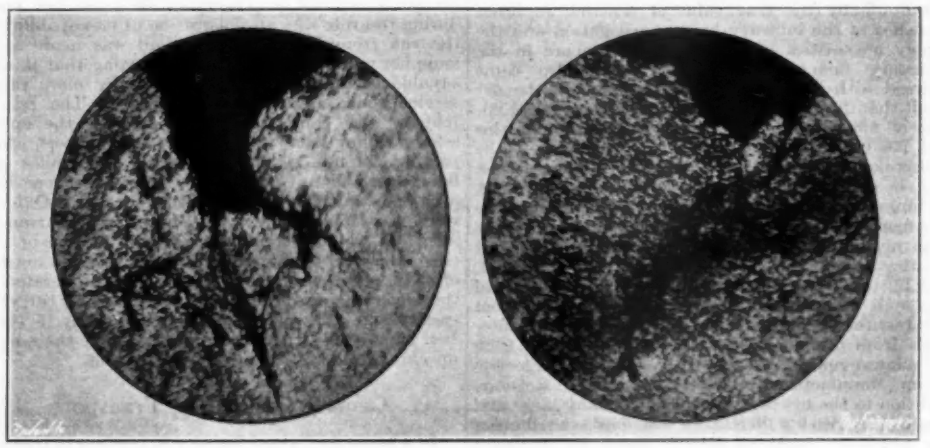
These conditions would only be completely fulfilled if the cavity were a nearly perfect vacuum. It seems reasonable to postulate that the cavity when entrapped will contain steam at the pressure obtaining at that point of the turbine. The greatest change of volume that could occur under these circumstances would result from the condensation of the steam to water. From this and from other considerations to be discussed later the conclusion may be drawn that the conditions in this case are not very favourable to the occurrence of cavitation, and that the maximum pressures that could be produced by cavitation effects could hardly be greater than those resulting from direct impact at the speeds usually met with in modern turbines.

It appears therefore that the maximum pressure that can be produced by an impact at 1000ft. per second is of the order of 40 tons per square inch. The resulting stress will be propagated through the metal of the blade as a radiating wave which will rapidly be dissipated by the absorption of its energy. The stress distribution will be of a complex nature, but so long as the impact takes place on a smooth surface the maximum intensity will not exceed the value of the pressure and will occur as a compressive stress at the point of application. As none of the materials ordinarily used for blading can sustain without injury stresses of this magnitude, the erosion of these materials in high-speed turbines could be adequately accounted for on the basis of this theory. It does not, however, afford a complete explanation of the phenomenon, for it is now known that extremely hard materials disintegrate under the action of water impact.

Later, a detailed description will be given of the research that has been carried out by the author's firm. In the course of this research it has been found that to prevent erosion a much higher degree of hardness is necessary than was at first anticipated, and although materials with a Brinell hardness of 600 possess such a high resistance that they are quite suitable for all practical turbine work even this hardness does not give complete immunity from erosion under test conditions at an impact speed of 1000ft. per second; 600 Brinell corresponds to an ultimate strength of well over 100 tons per square inch and a yield point practically equal to the ultimate. Local stresses of a much higher order than 40 tons have therefore to be accounted for. The most satisfactory explanation is afforded by the supposition that the pressure is generated not on a smooth surface, but at the bottom of a small pit in the metal. The stress distribution in this case would be completely altered and tensile stresses much greater than the pressure itself would be possible across the fibres surrounding the apex of the cavity, especially in materials with little or no ductility. It seems probable that the existence of such irregularities in the surface of the metal is essential for the erosion of these hard materials to begin. The converse is equally true—that some erosion is to be expected even on extremely hard materials owing to the practical difficulties of producing perfectly smooth surfaces. The irregularities need only be of microscopic dimensions, for, although the forces are large, the whole scale of the action is extremely small and the frequency of the impacts extremely high, conceivably 250 per second under the conditions of the experiments.

The research has led quite definitely to the conclusion that hardness is the most important property in determining the resistance of a material to erosion of this nature. Other factors, for example, ductility, may, however, influence the comparative rate of erosion as between two materials of similar hardness. It appears from what has been said above that if it were possible to obtain materials with tensile strengths of 100 tons or more, and in addition possessing appreciable ductility, the effect of the ductility in reducing the impact stress and so increasing the resistance might be considerable. No such materials are, however, at present available.

Though it is possible by mathematical analysis to arrive at an expression connecting the fluid pressure with the velocity of impact, it is not possible to find a similar connection between the velocity and the resulting stress in the metal. As a consequence, no useful relation can be traced between the yield point of a material and its resistance to erosion. Whilst the nature of the action producing erosion may be somewhat different according to whether the impact pressure is above or below the yield point, the transition is quite gradual and gives no visible indication. In the former case the metal undergoes minute local deformation due directly to overstress, and the deformation is extended at each successive blow until a fragment is completely severed. With intensely hard materials it is more likely that the stress does not reach the yield at each impact, but that the ultimate failure is brought about by fatigue. In both types of action the erosion is concentrated in the cavities which are worn deeper and deeper until they eventually break through into one another, and unite into larger pits.



FIGS. 7 AND 8—PITS IN AUSTENITIC STEEL

Some micrographs of characteristic erosion cavities are reproduced in Figs. 5 to 10. Fig. 5 is a section through a sample of tungsten steel—magnification 175—in which minute cracks spreading into the metal

FIG. 9—AUSTENITIC STEELS

at the cavities are clearly visible. Fig. 6 is a similar section through a pit in an austenitic steel sample—magnification 160—and shows the more violent disintegration of the softer material. Other examples showing the material surrounding the bottom of pits in the austenitic steel are reproduced in Figs. 7 and 8. These both show interesting crack formations and illustrate the manner in which minute fragments of the metal gradually break away. The tungsten steel had a Brinell number of 300 and the austenitic of 175. In Fig. 9 are sections taken from samples of two different austenitic steels and reproduced to lower magnifications to show the honeycomb structure of the eroded surface produced by the concentrated action at the pits. An examination of affected blades which have been exposed to the impact for a considerable length of time will show that many of the

* No. I. appeared February 5th.

individual cavities have extended so far that a series of holes has been punched right through the metal. An example of a perforation of this type through a brass blade is furnished by Fig. 10.

Though it is convenient at times to use the term critical point to denote the stage at which erosion becomes important for any particular material it will be clear from what has been said that there does not exist a definite critical velocity in the strict sense of the term. It has not been possible therefore to obtain empirical constants that can be

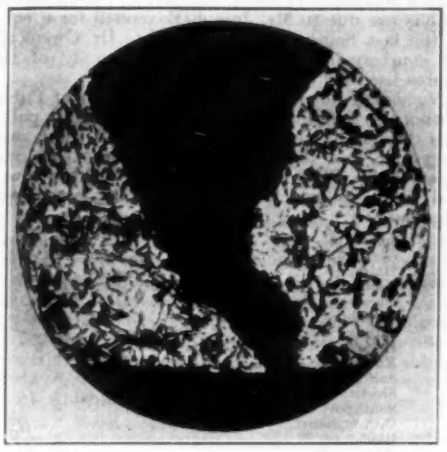


FIG. 10—PERFORATION OF BRASS BLADE

applied to the theoretical formula to give an arithmetical relation connecting pressure and velocity, and the question—how nearly are the theoretical values of the pressure actually obtained in practice?—must therefore remain unanswered.

PREVENTION BY BLADE PROTECTION.

It is convenient to divide the methods employed to prevent erosion into two classes, according to whether they aim at the production of blades capable of resisting the action of the water, or whether they

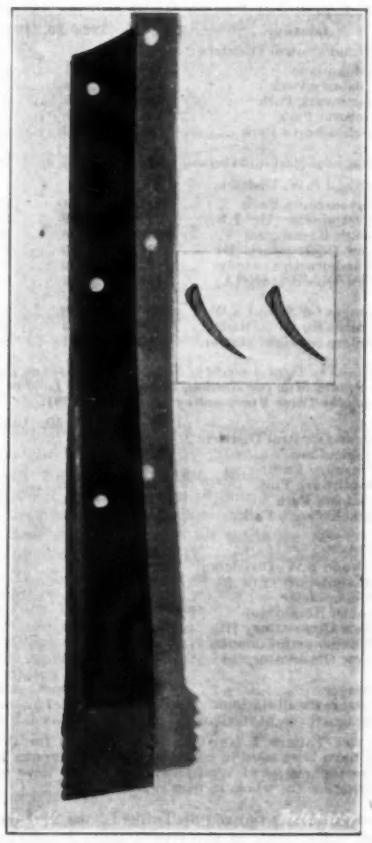


FIG. 11—TYPICAL PROTECTED BLADE

depend on reducing the quantity of water striking the blades by withdrawing it from the turbine as it condenses. To meet the severe conditions obtaining at the present day in high-speed turbines, it is desirable to make use of both these methods. By this means the longest life for very high-speed blades can be obtained. Were it possible to eliminate water entirely, this would, of course, remove the cause of the erosion and would therefore be the most direct solution. Unfortunately, however, there are fundamental reasons why the water cannot be entirely eliminated, and the practical difficulties of removing even a reasonable percentage are very great. For this reason the firm with which the author is associated has concentrated also on the production of blades possessing the highest possible degree of resistance.

A typical example of the form of blade now used is shown in Fig. 11. The particular example figured is employed for the last row in 3000 r.p.m. machines with tip speeds in the neighbourhood of 1000ft. per second. The blade itself is rolled integral with the root and is tapered in section from the root to a point half-way up the blade. From this point to the tip the profile is parallel and has the section shown in the figure. The ratio of the cross-sectional area at the root to that of the parallel upper portion is 3 to 1, a value which permits of an efficient design of blade and at the same time keeps the centrifugal stresses moderate. The blade profile is twisted so as to give the appropriate outlet angle at each individual point in its length. The blade is protected against erosion by means of an independent shield attached to the upper portion of the inlet edge and on the convex side. As the blade and shield are separate, each can be made in the material best adapted for its purpose. The properties required in materials suitable for blades differ fundamentally from those required to resist erosion. A blade material must, for example, possess adequate ductility to preclude the possibility of failure from fatigue under the influence of any vibration stresses to which it may be subjected in operation. It must also be suitable in every way for the processes of blade manufacture. On the other hand, the essential property for resisting erosion is hardness, a property possessed in the greatest degree by materials of a class quite unsuited for making into blades, but which can quite conveniently be employed for shields.

Another feature of the separate shield is the ease with which it can be removed and renewed. If, in process of time, the shields are worn down and replacement becomes necessary, the operation of renewing them is a very small matter in comparison with the alternative of replacing the complete row of blades. As the shield need only be applied over that area of the blade which is subjected to water bombardment, the protection can be concentrated on the leading edge and also it can be confined to a limited portion of the blade length. Frequently, the erosion is confined to a region at the tip of the blade extending for, say, one-third of the blade height. By confining the shield to this area the extra load which has to be carried by the blade, due to the centrifugal force of the shield, is kept quite small.

Reference to Fig. 11 will show that the shield strip has a cross section not unlike that of a turbine blade, but with the convex side of the leading edge bevelled off flat at about 45 deg. and with a slight hook at the inlet. The purpose of the hook is to make the shield self-locating, so that it will be held in its correct position by simply pressing it against the blade during the process of attachment, which normally consists of brazing. In the first commercial applications of this form of protection, the shields were bent in a die from sheet material to the curvature of the blade to be protected, and they were then fixed to the blade by two small rivets which served to hold them in place during the brazing operation.

The sheet metal shield was improved upon by the use of a rolled strip shaped so as to give the blade a definite bull-nose and of such a curvature as to give the greatest thickness of material just where the heaviest bombardment occurred. Shields of this type were fitted with the most successful results on some of the high-speed machines at that time in service, in which erosion had already proceeded to a considerable extent. This was accomplished by brazing the shield to the unaffected portion on the convex side of the blade, so as to cover the eroded area, and afterwards filling in the irregular cavities with silver solder from the concave side. As silver solder has a lower melting point than the brass used for the original brazing, this filling process did not disturb the attachment of the shield to the blade. For such cases it was found convenient to dispense with the riveting and to employ shields with a self-locating hook. This had the further advantage that the shields could be much more easily removed if, after some years of service, it was necessary to renew them, as the rather awkward operation of drilling out the rivets was avoided.

The bull-nose form of shield had the advantage of concentrating the greatest thickness of protection where it was most needed, but it incidentally resulted in the face of the blade at this point being practically normal to the direction of impact. It seemed reasonable to suppose that a shield with a bevelled face would possess an advantage over the bull-nose, because it would make the direction of impact oblique and a condition much less favourable to the building up of high pressures would therefore be obtained. Experiment confirmed this view, and led to the bevel form shown in the figure being adopted as the standard shape. The bevel extends to a point beyond the limit line of the exposed area, the tail serving merely to blend the shield into the blade profile.

Examples of eroded blades have been described in the first article. These examples have been chosen to illustrate the extreme effects of erosion, and have therefore been taken from old machines in which the conditions were particularly favourable to the action, and in which no steps whatever had been taken to deal with the problem. In Fig. 1, No. 4, is shown a protected blade for comparison. This blade has been taken from a machine in service, and would have been affected in the same way as the others had no protection been provided. Another example of protected blades is given in Fig. 12. This is of special interest, because it is reproduced from a photograph of the rotor of a machine precisely similar to the one from which blade No. 3, Fig. 1, was taken. The blades of the two machines are identical, except for the provision of protection in the case of Fig. 12. The photograph was taken after the machine had been in continuous service for a period of seventeen months, and a comparison of the blades demonstrates in a striking manner the effectiveness of the protection. The shields in these cases were of the bull-nose form, as the turbines were manufactured prior to the introduction of the bevel. The material in use at that time was an austenitic alloy with a hardness considerably less than half that of the tungsten steel employed in the more recent turbine, the last row of which is illustrated in Fig. 12A. These blades are absolutely unmarked, although some erosion was visible when the photograph was taken on the unprotected stainless steel blades of the preceding row.

FIG. 12

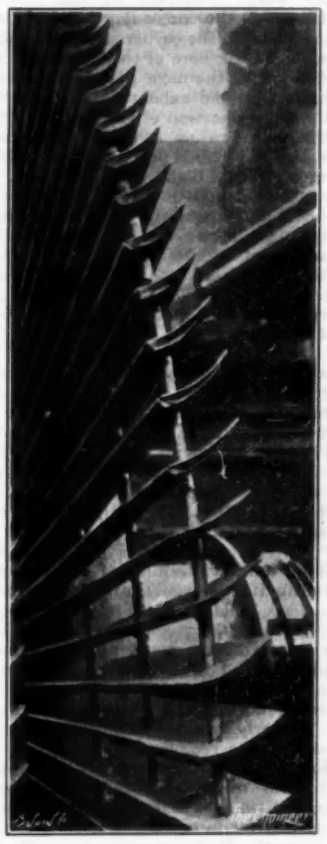


FIG. 12A

It is a fortunate circumstance that the steam-flow conditions for reaction blading are such that the shape of the blade inlet plays but little part in determining the efficiency, and can be changed considerably from the normal form without any detrimental effect. The design of the shields has not therefore had to be restricted from considerations of efficiency. In order that no doubt could exist on this point, comparative tests were carried out in the following way:—An experimental turbine was fitted with suitable blades of normal shape, and a series of steam consumption tests was made. Afterwards the rotor was completely rebladed having a shielded form of inlet edge, but otherwise similar to the original blades,

and the tests were then repeated. The two sets of blading gave identical efficiencies over the ordinary working range of velocity ratio. When the velocity ratio was reduced below 0·6, the efficiency of the shielded form began to fall away.

The same considerations apply to blades that have suffered in service. Erosion may proceed to an extent sufficient to make the blades very unsightly without the efficiency of the unit being affected. This is a point of great importance which is sometimes lost sight of. Renewal of blades does not become necessary until their mechanical reliability is endangered, and as in general the erosion is confined to that part of the blades where the stresses are relatively low, a considerable loss of effective section is usually permissible.

Removal of Water.

A 3000 r.p.m. turbine with a blade tip speed of the order of 1000ft. per second, is capable of handling some 90,000 lb. of steam per hour per exhaust at 29in. condenser vacuum. Taking as an example such a turbine operating with a steam pressure of 400 lb. per square inch, and 750 deg. Fah. at the stop valve, this steam quantity corresponds to an output of, say, 12,000 kW. The steam at the exhaust will have a moisture content of 12 per cent. The maximum quantity of water entering the last row of rotor blades will be 11 per cent., as the remaining 1 per cent. will only be condensed during the passage through the last row; 11 per cent. amounts to 10,000 lb., or, say, 4½ tons per hour.

It is reasonable to assume, however, that the water which causes erosion of the last row is limited to that which condenses out and forms drops on the blades of the preceding guide row. The water condensed in the earlier stages will have been thrown out on to the bore of the casing by centrifugal force, and will for the most part be retained there, passing through to the exhaust as a layer on the cylinder. A small proportion of this water at the top will tend to leave the casing, as the effect of gravity is not quite negligible. This is probably responsible for the rounding off of the blade tips, frequently observed. The water condensed in the fixed blades in the example above amounts only to about 1 per cent. of the steam quantity; that is to say, 900 lb. per hour. It may be of interest to note that, as a turbine of this size would have a total length of blading in the last row of some 2500in., this quantity, if uniformly distributed, would amount to 0·36 lb. per hour per inch of inlet edge.

It has already been explained, however, that actually only a fraction of this quantity is struck by the blades with a very high relative velocity. The major portion of it will be condensed so near the exit of the last guide row that it will continue to move with the steam jet and will enter the moving row without shock. It will thus be seen that only a very small percentage of the water is concerned in erosion. If this were not the case, the life of the blades would indeed be a short one.

Many attempts have been made to devise means of adequately draining the water out of the steam during its passage through the blading, and some turbine builders have relied entirely on this for a solution of the erosion problem. The advantages of withdrawing the water are obvious enough, and are not confined to the influence it has in this connection, so that such methods as can be applied with reasonable simplicity should certainly be employed.

Properly arranged, a simple system of drainage can be made to remove an appreciable quantity, but it does not appear to be possible even with the most elaborate arrangement to get rid of anything approaching the whole of the water. Unfortunately, the water most active in causing erosion is the most difficult to drain off. Draining can only be effective in removing the layer of water from the boundary of the blade annulus; that is, at the bore of the cylinder. Water is thrown out by centrifugal force against the casing by the rotating blades, and unless the cylinder shape or the arrangement of guide blades is such as to force it back into the blade annulus, it flows for the most part to the exhaust along the surface of the bore. A percentage of this water can be enticed out through the drainage ports, but, as explained above, the water which causes erosion does so before it has reached the bore, and therefore before it can be trapped into the drain.

Various schemes have been suggested in which an attempt is made to overcome this difficulty by the use of hollow blades arranged so that the water enters through openings in the concave face, and is led out to the periphery. The author is not able to say whether any of these schemes have been tried commercially, but their use would seem to be limited to large machines where very heavy blade sections could be employed.

Water does not drain out from a turbine cylinder nearly as readily as at first sight might be expected. If a plain radial hole is drilled into the bore practically no water will be discharged through it, even though it be connected to a vessel at a somewhat lower pressure. Such water as is discharged results mainly from condensation of the steam which is blown out. This is because the pumping action of the fast-moving rotor blades drives the water across the mouth of the hole instead of into it. An analogous effect may be observed in the case of wet steam flowing along a straight pipe with a drain hole in the bottom. If the steam velocity is high enough to give the water considerable momentum along the pipe, it will jump the mouth of the drain hole. To be effective therefore drainage holes must be tangential and not radial, and, of course, must face in the direction of rotation.

Withdrawal of water is greatly facilitated if there is an appreciable outward flow of steam through the drainage port; this can only be arranged for if the port is connected to a feed heater. Thus, an efficient water drain must consist of either an open mouthed belt with a tangential discharge branch at the bottom, or else a belt connected to the steam space by a ring of closely pitched tangential holes. The shape of the belt itself should be arranged so as to avoid as far as possible any likelihood of water falling back into the blade annulus and the discharge from the belt must communicate with a feed heater or equivalent means of utilising a reasonable quantity of steam.

The low-pressure stage of a normal feed-heating system can be utilised to a small extent for drainage purposes, but this will, in general, be fixed from other considerations at a point where comparatively little water will have separated out, so that it is not very effective as a drain. To return to the example cited above, suppose the turbine to be arranged for feed heating to 300 deg. Fah. in three tap-off stages, then the low-pressure stage will be at, say, 10 lb. per square inch absolute, at which pressure the theoretical wetness is not more than 4 per cent. These conditions are equally applicable to turbines operating at much higher pressures where intermediate reheating is not adopted. Although the percentage of moisture at the low-pressure tap-off stage is considerably greater, the amount of water which separates out beyond this stage is also greater.

Drainage between cylinders of a two or three-cylinder turbine is subject to a similar limitation. The steam pressure at the inlet to the low-pressure cylinder is fixed to suit a number of other considerations, and it would be inconvenient and decidedly uneconomical to alter it to a much lower pressure or to increase the number of cylinders solely for drainage purposes.

In recent turbines constructed by the author's firm, these considerations have been met by the provision of a drainage belt just before the last two stages of the blading. This belt is connected to a small drain condenser through which a portion of the condensate is passed in parallel with the ejector condensers. The arrangement of the belt is shown in Fig. 13, from which it will be noted that the tips

FIG. 13—DRAINAGE BELT

of the rotor blades in the previous row fractionally overlap the metal of the casing. The layer of water flowing from the casing bore into the mouth of the belt acts as the seal to prevent steam leakage. In a typical case the steam pressure at the belt is 1·5 lb. per square inch absolute, with 29in. vacuum in the condenser. At economical load on the turbine the water content of the steam is 9 per cent. at this point. A small heater is provided to heat one-fifth of the condensate 10 deg. Fah., which corresponds to a steam flow through the belt of about one-tenth of 1 per cent. of that passing through the blades. The steam temperature is 115 deg. Fah. at the belt, and the condensate temperature is 79 deg. Fah. This difference allows sufficient margin for the drain condenser to remain effective over a considerable range of load on the turbine.

(To be continued.)

THE Stationery Office publication known as the Tramway Returns shows that the tramway undertakings of Great Britain suffered, in the year 1930–31, a decrease of 5·56 per cent. in receipts, as compared with 1929–30, and reduced their expenditure by 3·26 per cent. There was a fall of 219 millions, or 4·75 per cent., in the number of passenger journeys, and of 2·76 per cent. in the car miles.

Air Pollution in 1930–31.

By JOHN B. C. KERSHAW, F.I.C.

THE information and figures given in this article are taken from the last three Annual Reports of the Meteorologist of the Southport Corporation, and from the latest Report of the Salford Medical Officer of Health. The Seventeenth Report on Atmospheric Pollution to the D.S.I.R., obtainable at any of H.M. Stationery Offices at the price of 5s. 6d. net, is now available to those interested. The author's thanks are due to Mr. Joseph Baxendell for a copy of the last Southport Report, and to Dr. Owens for his courtesy in guaranteeing the accuracy of the figures used for this article.

Number of Gauges in Use.—The number of Public Authorities carrying on observations upon air pollution during the year ending March 31st, 1931, was forty-four, and the number of gauges in use was ninety-eight. The following is the list of the towns and cities in which more than one gauge was installed:—

London	13
Glasgow	9
Halifax	5
Leeds	5
Burnley	3
Dewsbury	3
Edinburgh	3
Leicester	3
Newcastle	3
Salford	3
Sheffield	3
Southport	3
Birmingham	2
Blackburn	2
Bourneville	2
Bradford	2
Kingston (Hull)	2
Huddersfield	2
Liverpool	2
Rochdale	2
Rotherham	2
Stoke-on-Trent	2
Wakefield	2
Wallsend	2

The London Results.

An increase has again to be recorded in the air pollution of the Metropolis, this increase being most marked in the West and South-West districts. The figures are collected in Tables I. and II.

TABLE I.—*The Total Deposit of Solid Matters Collected in the London Gauges during the Three Years ending March 31st, 1931, Expressed as Tons per Square Mile per Annum.*

Locality.	1928–29.	1929–30.	1930–31.
East and Central Districts:			
Golden-lane	395	391	408
Finsbury Park	240	284	236
Southwark Park	304	279	256
Victoria Park	184	238	234
Archbishop's Park	268	233	310
Average for East and Central	278	285	289
West and S.W. Districts:—			
Ravenscourt Park	201	344	461
Westminster (D.S.I.R.)	251	299	288
South Kensington	260	228	229
Kew Observatory (B)	174	180	158
Wandsworth Common	179	169	178
Kew Observatory (A)	159	151	147
Averages for S. and S.W.	204	228	243
Averages for all stations	238	254	264
Averages for eight stations	253	271	289

TABLE II.—*The Total Amount of Sulphur, Expressed as Tons SO_3 per Square Mile per Annum, Collected in the London Gauges during the Three Years ending March 31st, 1931.*

	1928–29.	1929–30.	1930–31.
East and Central Districts:			
Golden-lane	39	42	47
Finsbury Park	26	32	27
Southwark Park	32	32	31
Victoria Park	24	26	26
Archbishop's Park	39	36	42
Averages	32	34	35
West and S.W. Districts:			
Ravenscourt Park	24	69	106
Westminster	27	28	24
South Kensington	28	25	27
Kew Observatory (B)	27	28	21
Wandsworth Common	22	20	22
Kew Observatory (A)	26	22	19
Averages	26	32	36
Averages for all stations	28·5	32·7	35·6
Averages for eight stations	29	35	41

N.B. FOR TABLES I. AND II.—The averages for the eight stations have been used in constructing the diagrams on page 177, since the gauges at Westminster and Kew have not been in operation for the whole sixteen years.

Examining the figures of Table I., we find that the average collections of the five gauges located in the East and Central London districts represented a deposit of 289 tons as compared with 285 tons in the previous year, and 278 tons in the year ending March 31st, 1929. The gauges at Golden-lane, Victoria Park and Archbishop's Park showed the largest increase of solid matter.

The average amount of impurity collected in the six gauges located in the West and South-Western districts, on the other hand, amounted to 243 tons. This average would have been considerably less if the gauge at Ravenscourt Park had not collected a deposit equivalent to 461 tons per square mile. This is nearly the highest deposit recorded by any gauge last year, and the increase of the deposit of solid matter at this observation station is phenomenal, since the figures for the three successive

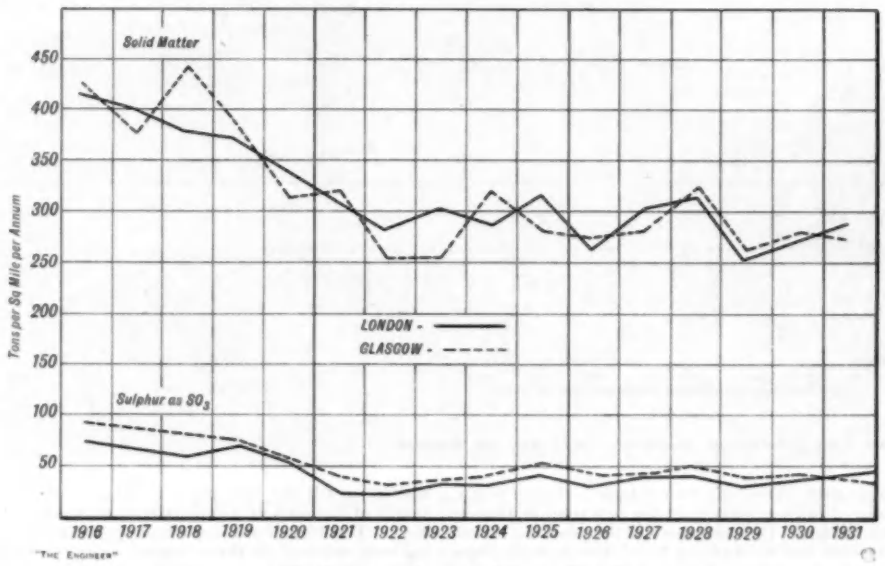
years are 201 tons, 344 tons and 461 tons respectively.

The average collection of solid matter from the six gauges operating in West and South-West London was 243 tons per square mile, and, as might be expected from the Ravenscourt Park figures, this is a considerable increase on the totals for the two previous years, which were 228 and 204 tons respectively. The corresponding figures for the whole of the eleven London stations are 238 tons, 254 tons and 264 tons, and these indicate the gradual increase of London's air pollution which is now in progress.

The figures for sulphur impurities are collected in Table II., and here again the Ravenscourt Park gauge is the one showing the greatest amount of impurity, the increase in the three years being from 24 tons to 106 tons per square mile per annum, or over fourfold. The sulphur impurity of the Golden-lane district, which at one time was regarded as one of the worst in the Metropolis, is now less than one-half this, while the sulphur acids collected at Kew Observatory are less than one-fifth. The reason for the high returns from Ravenscourt Park are not evident.

The average sulphur impurity for the eleven London stations is now 35·6 tons, as compared with 32·7 tons in the previous year, and with 28·5 in the year 1928–29. The diagram on this page shows the totals for solid matter and sulphur acids collected in the London and Glasgow gauges for the whole of the period of the observations. It will be noted that London's atmosphere is now dirtier and contains more sulphur acids than that of Glasgow, and that the improvement which occurred in the years 1928–29 has been lost.

The new observation gauge which has been installed at Westminster collected solid matter equivalent to 288 tons, and sulphur acids equivalent to 24 tons, during the last year. These totals are rather more than the average results for all the eleven London stations.



AIR POLLUTION OF LONDON AND GLASGOW

RESULTS FROM OTHER TOWNS AND CITIES.

Since the removal of sulphur acids is now being provided for in connection with the most recent super-power stations, it is of some interest to study the figures for sulphur pollution in some of the other towns and cities in which air pollution observations are being made. Table III. contains a comparative

TABLE III.—*Comparative Amount of Sulphur Collected by the Gauges in Ten Cities and Towns of the United Kingdom for the Three Years ending March 31st, 1931, Expressed as Tons of SO_3 per Square Mile per Annum.*

Town or city.	1928–29.	1929–30.	1930–31.
Bourneville	11·3	13·3	14·0
Southport	17·2	17·4	16·4
Leeds (Park-square)	36·8	36·9	38·5
Glasgow (aver. nine stations)	38·0	41·2	39·1
St. Helens	62·1	56·0	40·0
London (aver. eight stations)	29·2	35·2	41·1
London (Golden-lane)	39·0	42·2	47·0
Birmingham (Central)	34·2	43·8	48·3
Liverpool (Netherfield-road)	66·3	65·2	68·8
London (Ravenscourt Park)	24	69	106

statement covering the last three years for the towns showing the lowest and highest results as regards sulphur acids. Bourneville, as might be expected, heads the list for each of the three years, with Southport close behind it, while Glasgow and Leeds come above London, and Liverpool and Ravenscourt Park come at the bottom of the table.

Table IV. contains the comparative figures for the total deposits of solid matter in thirty-two of the towns and cities in which the air pollution observations are being carried on at the present time. It will be observed that the group with less than 200 tons per annum is growing larger, and that the centre group of the table, with deposits of between 200 and 300 tons per annum, is also increasing. This is clear proof that some progress in atmospheric cleanliness in the country generally is being made, in spite of the setback which has occurred in London.

Table V. contains the highest and lowest results for individual gauges, and here again Burnley and Liverpool, which occupy the lowest position in Table IV., show the worst results, while Wakefield, Bourneville Village and Gloucester occupy the highest places in the table, both as regards deposits of solid matter and of sulphur acids.

TABLE IV.—*Comparative Figures for the Total Fall of Solids in Thirty-two Towns and Cities of the United Kingdom during the Year ending March 31st, 1931, Expressed as Tons per Square Mile per Annum.*

Place.	No. of gauges in use.	Tons per annum.
Gloucester	1	108
Bourneville	2	112
Rothamstead	1	115
Marple	1	126
Southport	2	155
Wakefield	2	180
Cardiff	1	187
Wrexham	1	200
Cheltenham	1	202
Edinburgh	3	203
Kingston-on-Thames	1	216
Leeds	5	232
Leicester	3	241
Rotherham	2	242
Hull	2	245
London	11	264
Walsall	1	267
Newcastle-on-Tyne	3	273
Stoke-on-Trent	2	274
Birmingham	2	276
Glasgow	9	278
Sheffield	3	288
Loughborough	1	288
Salford	3	292
Rochdale	2	314
Castleford	1	356
St. Helens	1	362
Huddersfield	1	379
Liverpool	2	426
Burnley	3	469

TABLE V.—*Highest and Lowest Results in 1930–31 for Solids and Sulphur Acids at Individual Observation Stations.*

Station.	Total solids.	Sulphur acids.
Burnley (Town Hall)	549	42
Liverpool (Netherfield-road)	530	69
Ravenscourt Park (London)	461	106
Sheffield (Surrey-street)	444	37
London (Golden-lane)	408	47
Glasgow (Blythswood-square)	380	52
Wakefield (Clarence Park)	102	16
Bourneville Village	104	13
Gloucester	108	—
Rothamstead	115	—
Southport (Hesketh Park)	123	16
Marple	126	20

If the plant and apparatus which is now being installed in all the large power stations for washing the waste gases prove satisfactory and economical in running costs, it is possible that in time we may see similar installations adopted in all large works and factories where solid fuel is burned for steam-raising or other purposes. The air pollution of all towns and cities then may be reduced to the amount shown in the towns grouped at the bottom of Table V., but this state will only be attained when the domestic smoke problem has been solved, either by voluntary action or by legal penalties for all those who persist in burning bituminous coal in unscientific types of heating appliance. The experience obtained in Glasgow and Salford with the use of smokeless fuel seems to indicate that the law will have to be invoked, before the majority of citizens of our towns and cities realise the importance of a clean atmosphere, and their duty to reduce their own daily contribution of soot and dirt to a minimum.

THE CITY OF SALFORD ANNUAL HEALTH REPORT.

The progressive Medical Officer of Health for Salford, Dr. Osborne, continues to devote considerable attention to the subject of air pollution, and in his annual report for the year 1930 he states that the observations have been continued in relation to :—

(1) The comparison of efficiencies of solid fuels when burned in the "all-firebrick" type of open domestic grate.

(2) The measurement of atmospheric impurity at four different stations by means of the deposit gauge.

(3) The measurement and the strength of sunlight at four different stations by means of the potassium iodide test.

As regards the first subject, the report states that the experiments carried out during the past winter have confirmed the results obtained in previous years, and indicate that, weight for weight, vertical retort coke is much superior to the best house coal. The following table gives the average result of twenty-eight tests, and in order to obtain a fair comparison the experiments in which the respective mean room temperatures showed a greater difference than 0·50 deg. Fah. have been eliminated from the table.

Vertical Retort Coke versus *Best House Coal.*

Type of fuel.	Average room temperature, deg. Fah.	Average weight of fuel consumed per day, lb.
Vertical retort coke	63·6	14·2
Best house coal	63·7	19·6

The efficiency ratio in favour of vertical coke is therefore 1·35 to 1·0, although the calorific value of the coke when tested in the calorimeter was lower than that of the house coal. The greater efficiency of the coke is, of course, due to the fact that it contains only a small amount of volatile matter, and that its combustible matter is present chiefly as fixed carbon, whereas the house coal contained 31 per cent. of volatile matter, and the larger portion of this in most open types of grate escapes to increase the atmospheric pollution without heating the room at all. The following table gives details of the tests and prices of the two fuels, as delivered at the health offices in Salford :—

Vertical Retort Coke versus *Best House Coal—Comparison of Tests and Prices.*

Type of fuel	Retort coke	House coal
Volatile matter	1·54	31·05
Ash	11·03	7·82
Fixed carbon	86·81	58·12
Calorific value	12,879	13,487
Price delivered	25s. 10d.	25s. 2d.
Retail price	25s. 10d.	40s. 0d.

It will be seen from the above statement therefore that even at the Council Offices, where the coal is purchased at the wholesale price at which it is delivered at the gasworks, vertical retort coke is considerably the more economical heating agent, and that if the coal had to be purchased at the ordinary retail price in Salford, the cost of heating a room with the aid of coke in place of coal would be reduced by one-half. It would seem to be a question of time only, therefore, before coke displaces coal as a domestic fuel. The chief features of the grate are a fire-brick hearth and chimney breast, and, according to the Medical Officer

TABLE VI.—*Comparison of the Salford with the Newcastle and Birmingham Returns.*

	Salford.				Newcastle.	Birmingham.
	Peel Park.	Ladywell Sanatorium.	Regent-square.	Marple Sanatorium.	City-road.	West Heath.
Rainfall in millimetres	75·31	71·19	91·70	89·99	73·00	82·00
Insoluble matter	7·71	3·55	8·23	1·51	22·28	1·43
Tar	0·50	0·28	0·69	0·14	0·66	0·04
Carbonaceous matter	2·10	1·26	3·00	0·79	9·75	0·42
Ash	5·11	2·01	4·54	0·58	11·87	0·97
Soluble matter	3·76	2·49	3·28	1·82	7·45	2·76
Loss on ignition	1·21	0·89	1·23	0·85	2·20	0·96
Ash	2·55	1·60	2·05	0·97	5·25	1·80
Total solids	11·47	6·04	12·51	3·33	29·73	4·19
Sulphates	1·06	0·81	1·12	0·60	2·50	0·87
Chlorine	0·85	0·88	1·15	0·63	0·90	0·32
Ammonia	0·03	0·03	0·09	0·04	0·19	0·06

N.B.—The Salford figures are for the year ending March 31st, 1930, while those for Newcastle and Birmingham are for the year ending March 31st, 1928.

of Health, the conversion of any ordinary fire-place to the newer type can be carried out with the expenditure of a comparatively small amount upon glazed fire-bricks and for the services of a skilled bricklayer.

Concerning the second subject, namely, the measurements of atmospheric pollution at four different stations, Table VI. on page 177 contains a comparative statement of the average figures for the four Salford stations and for the two stations at Newcastle, City-road, and at West Heath, Birmingham, which represented the highest and lowest returns respectively for solid impurities in the rest of the country in 1928 :—

As regards the measurements of the strength of sunlight by means of the potassium iodide test, the Salford investigations have shown that the results obtained by this method vary considerably at the different stations, according to the direction of the wind ; but that the week-end closing down of the mills and factories does not seem to have much influence on the results. The City Analyst reports on these tests as follows :—

> "It will be seen that the figures for Regent-road are, in general, lower than those for the other three stations, and this gives some idea of the smoke blanket which hangs over the centre of the city. Other factors, such as ground mist, cannot, of course, be taken into consideration, but in general the figures show that the active amount of sunlight received in the centre of the city is considerably less than the amounts received at the outlying stations.
>
> "It is well known that this test [potassium iodide] is only an approximate measure of sunlight, and since the experiments are carried out in glass bottles the method takes no account of the extreme ultra-violet part of the spectrum which is present in bright summer sunlight. In the past year it has also been discovered that the purity of the potassium iodide employed affects the result to a considerable extent."

In reply to an inquiry why the potassium iodide test had been employed at Salford, in place of the more usual Stokes method for registering sunlight, Dr. Osborne has stated that in the locality there are many months and seasons of the year when sunshine is a rarity, and what was required in Salford was a comparative record of daylight rather than sunshine. There were many degrees of daylight in that district, varying from brightness to gloom, according to the amount of smoke suspended in the atmosphere, and the potassium iodide test did give some indication of the variations in the intensity of the available light. It was believed that the figures closely followed the ultra-violet figures, and the potassium iodide test certainly seemed as reliable as the method recommended by Professor Leonard in which acetone-methylene blue was employed.

THOSE interested in the London Passenger Transport Bill, which was carried forward in its then state from the late Parliament to the present, are anxious as to its prospects, seeing that it was not mentioned by the Prime Minister in his statement of the intended business for the current session. Mr. Baldwin was therefore asked a question on the subject on February 4th, but his reply was that he was not in a position to make any statement.

New Railway Bridge over the North Circular Road.

IN connection with the construction of the North Circular Road by the Middlesex County Council, it has been necessary to form an underline bridge to enable the road to pass under the London and North-Eastern Railway at a point on the railway about 24 chains south of New Southgate Station. The Railway Company, following the practice it adopts in all cases in which bridges have to be constructed under existing lines, is building the bridge on behalf of the County Council.

At the site the surface of the railway embankment is about 36ft. above the level of the adjoining natural ground surface, and the position was therefore very suitable for an underline bridge. The railway there comprises an up and a down main line, and an up and a down "slow" line, and two sidings ; that is to say, six lines of railway pass over the new road at the site of the bridge. It was possible therefore to divert traffic from fast to slow, or from slow to fast, lines, during the least busy hours of Saturday night and Sunday, and thereby to enable girders to be placed under lines temporarily put out of use.

In order to make provision for future widening of the railway, it was necessary to construct a bridge long enough, not only to carry the six existing lines of railway, but long enough to carry, in addition, one more line of way on the down side, and a number of additional lines on the up side. It was decided, therefore, to make the bridge in two parts, one carrying the railway lines, of steel, the other, on which there are no lines at present, of concrete. The span of the steel bridge is 70ft. on the square and 73ft. $10^{5}/_{32}$in. on the skew, the angle of skew being 71° 25′ 30″. The total length of the bridge, measured on the centre line parallel to the run of the abutments, is 366ft.—see Fig. 1. The superstructure of the metal parts of the bridge is built up of longitudinal steel girders and steel decking for a length of 130ft., while for a length of 232ft. the superstructure is a concrete arch. There is a space of 4ft. between them to admit light. The steel bridge carries the six existing railway tracks, and there is width sufficient for an additional track on the down side. The concrete arch is to carry the lines and sidings which the company may find it necessary to lay down at a future date on the up side of the line. The comparative ease with which steel girders can be laid under running lines of railway without unduly interrupting traffic, led to the adoption of steel for part of the superstructure of the bridge.

The concrete arch is of 70ft. square span—73ft. $10^{5}/_{32}$in. skew span—with a rise of 20ft., and is segmental. It is constructed of Portland cement concrete, the proportion being 4 parts of aggregate, 2 parts of sand, and 1 of cement, rapid-hardening cement being used, and it is not reinforced with steel. The sectional diagram, Fig. 2, illustrates the method of loading the centering. The area marked "1st day's work" shows the concrete deposited on the first day, and so on till the 6th day. By this method a 36ft length of the arch of complete section was built in six days. The timber framework supporting the centering was erected on three bogies which travelled on rails, so that, when on completion of a 36ft. length, the wedges were withdrawn, and the framework and centering were lowered on to the bogies, the bogies could be moved forward on the rails until the centering was in position for another 36ft. length of the arch to be begun.

The arch is 3ft. thick at the crown and 4ft. 6in. thick at the springing. It was constructed of concrete instead of brickwork in order to save time and cost, this saving being due partly to the difficulty of obtaining bricklayers in the locality at the time of starting work on the arch. Moreover, more light is reflected from the concrete arch soffit than would have been reflected from a soffit of bricks. In order to give the concrete a smooth face, the lagging boards of the centering were covered with asbestos sheets before concreting was begun.

The abutments and wing walls of this part of the bridge are also constructed of Portland cement concrete, faced with brickwork, 9in. and 13½in. in thickness, the 13½in. courses being at intervals only in order

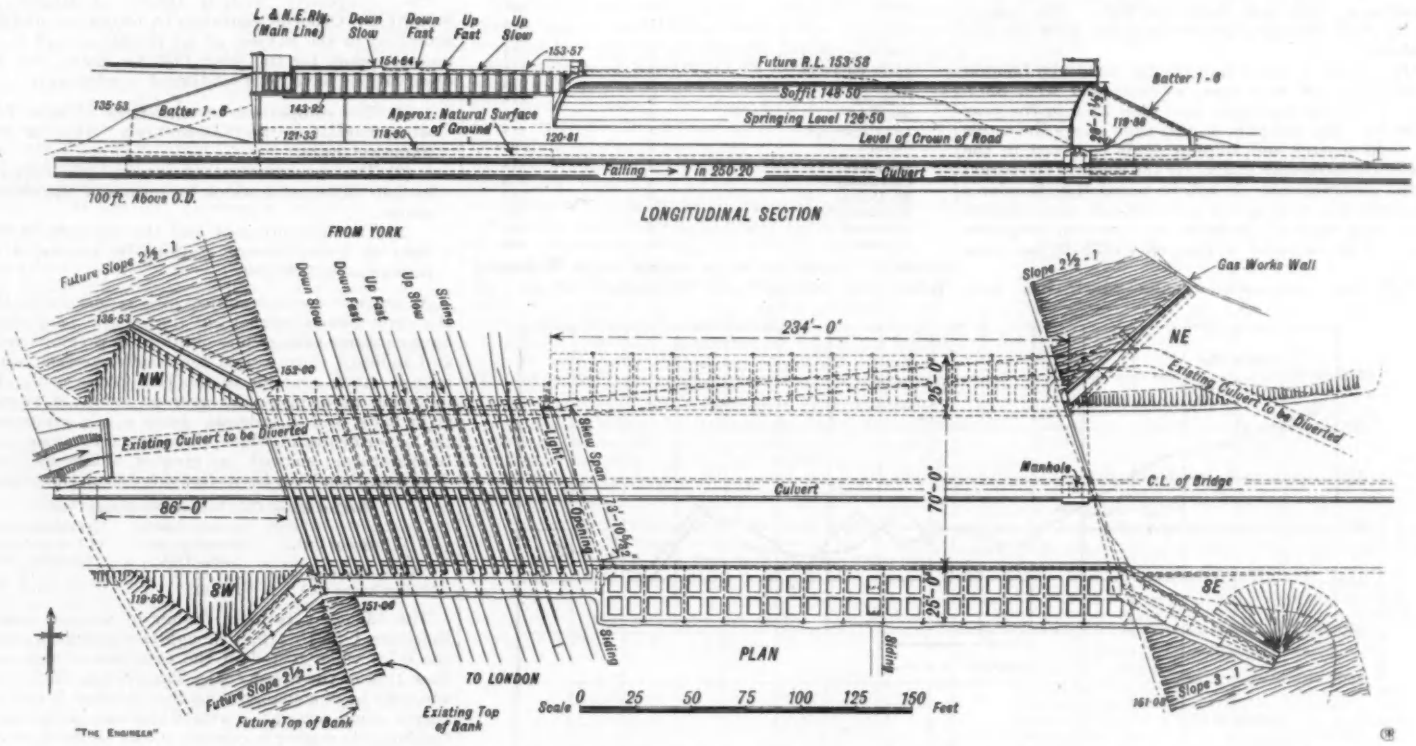


FIG. 1—PLAN AND ELEVATION SHOWING LAY-OUT OF BRIDGE

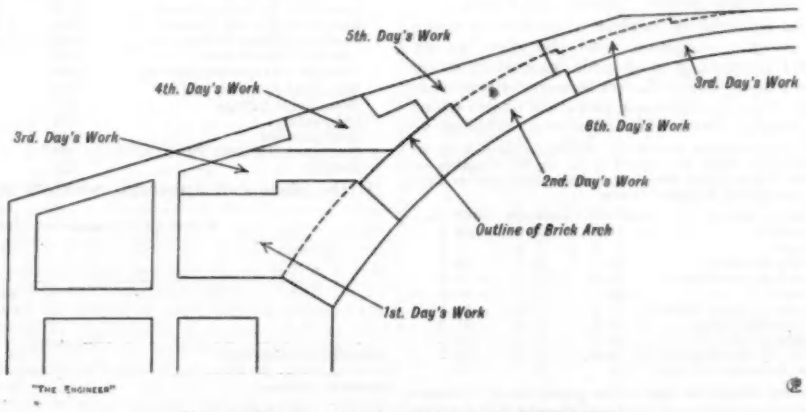


FIG. 2—METHOD OF LOADING THE CENTERING

to key the brick facework to the concrete backing. The facing bricks of the abutments are white-glazed, excepting only the first three courses above footpath level, and the three courses immediately below springing level, which are of pressed blue bricks. Owing to the necessity for spreading the weight on the foundation, the abutments are not solid, but cellular, with pockets 6ft. by 8ft. left in. The overall thickness of each abutment is 25ft. They are carried down to a depth approximately 10ft. below road level. There is a continuous rubble drain, 12in. thick behind each abutment, and the drainage is carried from the rubble at the back by means of 4in. weep-hole drains to a pipe drain laid under the footpath at the face of the wall. The surface of the arch and abutments is covered with a continuous layer of asphalt of 1in. thickness. The thickness of ballast between the asphalt surface and the underside of sleepers over the crown of the arch will be 1ft., which will give cushioning sufficient to absorb the shock of passing trains.

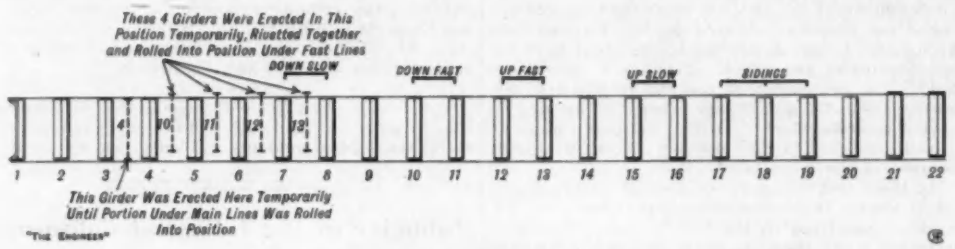

These 4 Girders Were Erected In This Position Temporarily, Riveted Together and Rolled Into Position Under Fast Lines
DOWN SLOW
DOWN FAST
UP FAST
UP SLOW
SIDINGS
4
10
11
12
13
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
This Girder Was Erected Here Temporarily Until Portion Under Main Lines Was Rolled Into Position
"THE ENGINEER"

FIG. 3—DIAGRAM ILLUSTRATING SEQUENCE OF ERECTION OF GIRDERS

To form an idea of the method of building the 232ft. length of the bridge which has a concrete arch, and which is not under the existing railway tracks, it should be noted that the surface of the embankment was about 23ft. above the level of the springing of the arch. After this embankment had been excavated down to approximately the springing level of the arch, trenches were dug down on each side to foundation level, in which the abutments were built. The earth in between the abutments having already been removed down to the level of the springing, the centering was erected thereon and the arch built over—see page 186.

Reverting now to that part of the bridge which has a steel superstructure, and which has been built under the railway running lines and sidings, its length, measured parallel to the abutments, is 130ft., and its clear span 70ft. The superstructure is composed of twenty-two plate girders placed to lie longitudinally in the direction of the railway tracks, and of steel decking riveted to the top flanges of the girders. The girders are laid parallel to each other, 5ft. 6in. apart, and are braced together with diaphragms. They are each 83ft. long, 8ft. deep, 1ft. 6in. wide, and 23¼ tons in weight. Each of the girders arrived on the site complete as a whole, having travelled from Middlesbrough loaded on the railway company's special wagons.

The steel decking is of sufficient strength to allow the railway tracks to be placed in any position on the bridge, and is covered with asphalt 1in. in thickness. Brindled tiling is laid on the asphalt to protect it from being damaged by the pick and shovel of the railway platelayer.

A brief account of the manner in which the girders were placed under the railway tracks may be of interest. Careful preliminary arrangements had to be made and a programme drawn up by the railway staff in conjunction with the contractors. Before any excavation in trench for foundations and abutments was begun, temporary rolled steel joists, 28ft. and 30ft. in length, were inserted under each rail of the railway lines. The ends of these joists rested on timber cribs built up of railway sleepers, three sleepers deep, the cribs being so spaced that no span exceeded 30ft. from centre to centre. This temporary superstructure of steel joists and cribs was placed under the rails on successive Sundays, when one or other of the tracks could be put out of use. The two outermost cribs were outside the line of the back of the abutments, so that excavation in trench for the foundations and abutments could be proceeded with without disturbing the cribs or interfering with the joists under the rails.

The abutments having been built in trenches up to girder bed level, the down fast and down slow lines were put out of use at midnight on Saturday, October 24th, and girders 1, 2, and 3—see plan, Fig. 3—were lifted on their seatings on the abutments, the embankment under these girders having been previously excavated to a level just below the bottom flanges. At the same time girder No. 4 was placed temporarily alongside girder 3. To perform the lifting operations, two of the company's locomotive cranes, each of 35 tons capacity, standing on the down slow line, lifted the girders out of the wagons standing on the down fast line and lowered them into position. The down fast and down slow lines were again brought into use for traffic by midday on Sunday. The decking, asphalting and tiling were then completed over girders 1, 2, and 3, and on Sunday, November 7th, the down slow line was slued into a temporary position over girders 2 and 3.

During the week-end of November 14th and 15th, the engineers took possession of the up and down fast lines, and girders 10, 11, 12, and 13 were lifted on to the abutments in the space between the down fast line and the down slow in its temporary position. Girders 10, 11, 12, and 13 were then completed with decking, asphalting, tiling and diaphragms fixed complete. While the superstructure required for the two fast lines was being riveted up, girders 17, 18, 19, 20, 21, and 22 were lifted into position during the week-end of November 28th and 29th, the cranes working on the up slow line, the wagons with girders standing on the up fast line. Then, on December 5th and 6th, the engineers again took possession of the up and down fast lines; rails, cribs, and joists were removed from under these tracks, mechanical excavators were put to work to excavate the embankment from under the tracks, girders 10, 11, 12, and 13 were rolled along the abutments, on hardened steel balls, 2in. diameter into their final position under the up and down fast lines, and the tracks were relaid over the girders. The reason for adopting this method for the two fast lines was that the company's engineer would not allow them to be slued over, as was done with the down slow line, and consequently the girders and flooring, complete with their asphalt and tiling, had to be prepared at the side and rolled into position on one Sunday, as possession could not be obtained for a longer period.

On Sunday, December 13th, the joists and cribs were removed from under the up slow line, girders 14, 15, and 16 were placed in position, and the line was relaid over them. During the week-end of December 19th and 20th, girder 4, which had been temporarily placed alongside girder 3, was slueed into position, and on the remaining girders 5, 6, 7, 8, and 9 were lifted into position by the cranes standing on the down fast line, the girders being in wagons on the up fast line. This operation is shown in Fig. 3.

FIG. 4—GIRDERS UNDER DIVERTED SLOW LINE

FIG. 5—FOUR MAIN GIRDERS READY TO BE ROLLED INTO POSITION

The abutments and wing walls of the steel bridge are built solid, of Portland cement concrete. They are 12ft. thick, and are faced with brickwork, 9in. and 13½in. in thickness, the 13½in. courses occurring only at intervals to act as a bond into the concrete. The abutments are faced with white glazed facing bricks between the same levels as in the case of the abutments which carry the arched superstructure, the remaining portions being faced with blue brindled bricks.

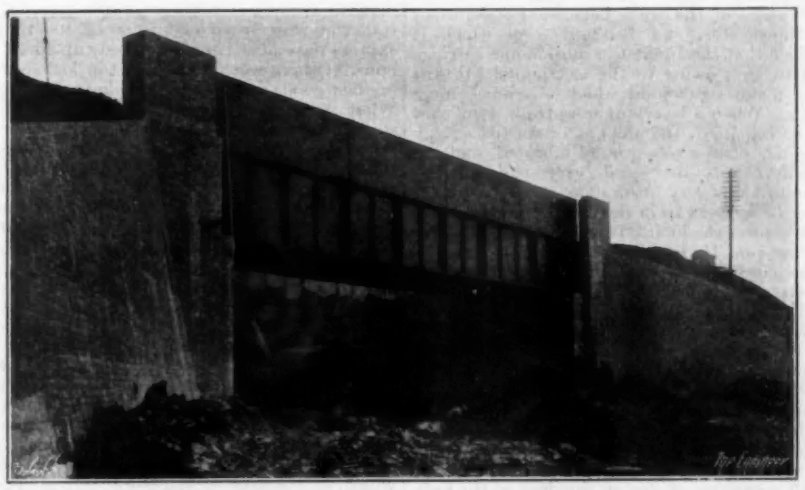


FIG. 6—GIRDER END OF THE BRIDGE

A subsidiary, but yet considerable, part of the work in connection with the bridge was the diversion of the watercourse known as Bounds Green Brook. This stream passed under the railway embankment by a culvert, and it was found that this culvert coincided, for

the greater part of its length, with the position to be occupied by the north abutment of the concrete arch; the culvert would, in fact, be exposed in the course of excavating for abutment foundations. As it was not desirable to leave it under the abutment, a new 6ft. diameter culvert was constructed along the centre line of the new road, with its soffit at a depth of 4ft. below the level of the crown of the road. The length of the new culvert is 618ft., and of that total a length of 455ft. was formed by tunnelling, the remainder being constructed by laying 6ft. diameter reinforced concrete pipe surrounded with 9in. of concrete in open trench. The part carried out by tunnelling is lined with McAlpine's patented pre-cast concrete segments, the segments themselves being coated internally with 3in. thickness of 6 to 1 Portland cement concrete reinforced with ⅜in. diameter rods running longitudinally in the direction of the tunnel, and, finally, lined with brindled bricks 4½in. in thickness. Brick lining was put in owing to its greater resistance to erosion by solids or injurious liquids. The excavation for the culvert was through clay, and it was found possible to excavate 2ft. ahead of the finished work and to build up the segments without timbering. When the brook had been diverted into the new culvert, it was possible to remove the old culvert in the course of excavating for the bridge foundations, the void created by the disused portion of the culvert when clear of the bridge foundation being filled up with weak concrete.

The work is being carried out to the designs and under the supervision of Mr. Chas. J. Brown, C.B.E., M. Inst. C.E., Engineer of the Southern Area of the London and North-Eastern Railway, and under the immediate control of Mr. R. F. Bennett, M. Inst. C.E., the company's late Assistant Engineer for Construction in the Southern Area. The work of constructing the new road under the bridge is being carried out by the County Council itself under the supervision of the Middlesex County Surveyor, Mr. A. Dryland, M. Inst. C.E., the contractors for the bridge being Sir Robt. McAlpine and Sons, Ltd.

Institution of Mechanical Engineers.

NORTH-WESTERN BRANCH.

A MEETING of the North-Western Branch of the Institution of Mechanical Engineers was held at the Engineers' Club, Albert-square, Manchester, on February 4th, Professor Dempster Smith in the chair, when Mr. J. D. Twinberrow's paper on "The Mechanism of Electric Locomotives" was read.

Professor Miles Walker, F.R.S., opening the discussion, referred to the author's treatment of the very important subject of the impulse given to the wheels and gears when passing over an obstruction, more particularly rail joints. The subject of rail joints, Professor Walker remarked, did not receive anything like as much attention as it ought, either in steam or electric traction. If there were one point which was important for electric traction in the future, it was that the trains should move smoothly at a high speed. If they were going to beat the motor omnibus in competition, they had to have smooth running and high speed as well. It could be proved that most of the jolting in the train was caused by rail joints. At the College of Technology they had been making a study of that subject for many years, and they had an apparatus for measuring the amount of movement in the train. He had with him a record of the vibration of the train between London-road Station, Manchester, and Buxton, from which it would be seen that the amount of motion in a carriage amounted to ⅛in., owing to the rail joints. It was possible to make a rail joint which was much more satisfactory. When a heavy express train went over an ordinary rail joint, the amount of wasted energy was appalling. The whole ground vibrated, and the tractive effort was decreased very considerably. The total effect was very much more than that represented merely by the gap in the rail; what did harm was the bending of the joint. It was quite common for a rail to move ¼in. He felt that the difficulty of changing over from ordinary steam to electric traction would be so great that oil-electric locomotives would be tried, and that they would ultimately prove economical and satisfactory for all kinds of loads.

Mr. T. Ferguson also discussed the hammer action at rail joints, and raised the question whether the amount of damage done was sufficient to make it worth while to pay for the extra complication of the gear which was necessary to avoid it. In locomotives of large power, it was, he claimed, an advantage to depart from the space restrictions of the axle-mounted motor, and mount the motor on the deck of the locomotive where there was room to install a large motor.

Mr. F. Whyman said that railway engineers using axle-hung motor locomotives often complained that slipping of the wheels occurred at a much lower tractive effort than was to be expected. That result was probably to be attributed to the fact that their calculations had been made in the way favoured by Mr. Twinberrow. When an axle driven by an axle-hung motor was exerting a tractive effort T at the rail, if S were the horizontal distance between the motor nose suspension and the axle centre and d were the driving wheel diameter, then the motor nose exerted a force $T \cdot d/2S$ on the truck frame and the motor axle bearing exerted an equal force of opposite direction on the axle. The directions of those forces were dependent on the direction of travel of the locomotive. Their effect on the rail reactions depended on the arrangements of the truck and spring systems, and the disposition of the driving motors. Mr. Twinberrow's expression indicated that the smallest rail reaction on the South African locomotive was 15·65 tons. Actually, the correct figure was 14·38 tons, a difference of 1·27 tons, or more than double the loss of rail reaction indicated by Mr. Twinberrow's expression. It was interesting to note that by using that feature of the axle-hung motor a locomotive could be so designed that the rail reactions of the driving axles did not change when the locomotive exerted tractive effort, and that the only difference of rail reactions under tractive effort conditions occurred in the idling axles.

Mr. Bond said that as a steam locomotive engineer, it had always been rather amazing to him that the freight locomotives on the G.I.P. were not allowed to travel more than 35 miles per hour. Special recorders were placed on the locomotives to provide a continuous record of the actual speeds attained. He could not quite see why those locomotives should be so restricted. In steam practice, any locomotive with 5ft. diameter wheels could attain 60 to 70 miles an hour quite safely. He had ridden on electric locomotives at speeds up to 45 miles per hour, and one engine had actually reached 52 miles per hour without any trouble developing. Continuing, he remarked that in the detailed design of the connecting-rod big end and of the coupling-rods of Mr. Twinberrow's locomotives, there appeared to be a great possibility for simplification. For example, the oil box on the top of the connecting-rod was provided with a lid with a number of set screws, for which he failed to see the object. He knew from experience that that lid was the cause of a great deal of trouble as regarded oil leakage. Further, the big-end bearings were made of steel with a white metal lining, but underneath there were some metal strips which caused a great deal of trouble. On the coupling-rod there were a number of serrations in the bush, and the white metal linings were sometimes liable to crack. Another complication resided in the excentric adjusting pin between the two rods. If the locomotive were designed and built properly, there should be no necessity for such a pin. There was one very weak point in the design of the brake gear. There was a compression member between the power brake system and the hand brake system, and if a single pin dropped out, the whole of the brake gear would become inoperative. In most steam locomotive practice it was possible to screw the hand brake on and take the power brake off, and *vice versâ*, without either system being affected.

Mr. H. H. Andrews said that there was one of Mr. Twinberrow's conclusions which he felt he must challenge, namely, the condemnation of the double-bogie locomotive with nose-and-axle suspended motor. In stressing the bad effect of that type on the track, they must not lose sight of the fact that it was capable of a very great range of useful work. It was compact and robust, and mechanically there was nothing to go wrong with it because it was so simple. Admittedly, it could only be satisfactorily used at moderate speeds, but what were moderate speeds? The English Electric Company's experience with a considerable number of such locomotives on the French, Japanese, and New Zealand railways proved that they rode satisfactorily. Among these locomotives were some of 96 tons, hauling 4000-ton freight trains at slow speed and some of 100 tons hauling express passenger trains at speeds up to 65 miles per hour. Others were 50 and 70-ton locomotives hauling fast goods and fast intermediate passenger trains. What speed had Mr. Twinberrow in mind when he stated that that type was suitable only for slow speeds? As he understood it, the gravity of the charges against the type lay in its effect on the track. Here, he agreed, there was an objection which had to be met. There was nothing inherent in the type of locomotive nor in the nose-suspended motor which prevented either being used in conjunction with a flexible drive. There were designs in existence to provide it, and he suggested that the reason that those designs were not actually running on the road was because the designers and manufacturers of electric locomotives had not up to now been asked to supply locomotives in which that feature was incorporated. There was little doubt that in any general electrification scheme there was a big scope for double-bogie motors. That remark would apply also to six-axle locomotives which presented the same characteristics as the four-axle locomotives. In the last half-dozen years, during which, as would be seen, great advances in design had been made, only two general types had been called for, either double-bogie, slow-speed locomotives, or else locomotives so powerful or so combining speed with tractive effort that no four-axle locomotive could comply with the specification.

Mr. Dodd, referring to the G.I.P. articulating joint, mentioned tests on the wear of tires on locomotives running without that gear. Although the results were not conclusive, they showed, he said, less wear on tires without the controlling gear than with it. Comparing the wear of tires in the Krauss type of truck with the pivoting centre placed a little forward of the driving axle and in the Java truck, he observed that whereas that on the Java driver was practically uniform with its partner drivers after 100,000 miles, the wear on the driver in the Krauss truck was considerably less than that of its partners after 100,000 kiloms.

Mr. Twinberrow, in reply, said that he regarded the question of impact as very important in connection with electric traction. If they could run over gaps at 60 to 70 miles an hour, they would reduce the impact. Any attempt to support rail joints rigidly was bound to result in failure. If they could do something to eliminate the joint, either by welding or in some other way, so much the better.

We greatly regret to have to record that Mr. James Denis Twinberrow, the author of the paper referred to in this article, died suddenly on Wednesday, Feb. 10th.

Publicity in the Editorial Columns.

AT a recent luncheon Mr. W. H. Temple, of the A.G.E., spoke to the members of the Incorporated Society of British Advertisers upon the attitude of the Publicity Manager to the Technical Press. With his permission, we reprint part of his excellent advice.

If you are hoping that I shall provide you to-day with some kind of formula or "Open Sesame" to the editorial columns of the Press, I am afraid you will be sorely disappointed. I only wish I had some such recipe, but I am afraid that none exists. All I can do to-day is to summarise and focus attention upon certain general principles with which I have no doubt many of you are familiar, and illustrate them with a few examples.

I propose to deal with the question chiefly as it affects our relationship with the technical journals, because as the engineering section of the I.S.B.A. we are more deeply interested in technical journals, and it is these technical journals which are of the greatest use to us.

I am rather glad that so many representatives of the Press have been able to come here to-day, because it gives us advertisers an opportunity of showing them that our attitude towards technical journals is not quite so cynical as is sometimes supposed.

We do not demand editorial notices as a right, nor, on the other hand, do we regard them as something that can be obtained only in an underhand way—by trying to slip a puff into some other matter which is sent in as news. I have no time for such cunning. It very seldom succeeds in getting past the editor, and even if it does get into print, it does the manufacturer very little good. No; we should take up a straightforward man-to-man attitude, sending in news about our activities, descriptions of our products, and so forth, because we think that the information will be of interest to the readers of the journals. And although we do not regard a mention in the editorial columns as a favour, we do realise that the publicity given is valuable to us, and our thanks are therefore due to the editor who is responsible.

The technical journal is part of our industry, just as the manufacturer and the user are parts of the same industry. It exists as a clearing house for the news of that industry. News concerning our manufactures is of interest to everybody connected with the industry, and editors are not giving a complete service to their readers unless they publish impartial descriptions of new machinery and plant, details of interesting installations, unusual applications of standard products, and so on.

It may be objected that the advertisement columns are the correct place for such announcements, but if an editor wants to tell his readers all that is going on in their industry, he must include news of manufacturers' activities, and must give impartial editorial notice to all manufacturers, whether they are large or small advertisers, or even if they do not advertise at all.

This question of the relationship between the advertisement and editorial departments is a thorny one. The polite view to take is that there is no connection between the editor and the advertisement manager, but that, I am afraid, is not true. There are very few journals, and here I include the general Press as well as technical papers, in which there is not at times, some collusion between the advertisement and editorial departments.

One always has a better chance of getting into the editorial columns of papers in which one advertises than in papers which do not carry the advertisements, but since journals must make a profit or go under, I suppose this cannot be helped.

There is, however, a very great difference between the journal which gives, shall we say, a slight editorial bias in favour of its advertisers and the publication which deliberately offers editorial publicity as a bait.

We have all met the advertisement representative who states quite plainly that the inclusion of a certain firm's plant in an editorial review is dependent upon advertising "support," and I dare say every advertisement representative knows the type of advertising manager or space buyer who never fixes up a contract without asking the question, "What about a write-up?"

I hate the term "write-up," because it shows a complete lack of appreciation of what the editor and reader want. A reader wants interesting matter written from his point of view, and not a lot of uninteresting stuff which is written up to please some manufacturer. He will not bother to read it anyway, so the manufacturer is no better off.

I said just now that the editor of a technical journal should give impartial treatment to all manufacturers, but, of course, he must be put in possession of the information, and the better it is presented to him, the easier his job becomes, both to his advantage and to that of the manufacturer.

The advertising man who wants to obtain for his firm its full share of editorial attention must cultivate something of the attitude of a working journalist, particularly that of the free-lance journalist who depends for his

existence upon his ability to anticipate the requirements of editors without receiving any instructions.

Incidentally, the journalist's alertness of mind will help the advertising man in preparing his advertisements, or in making constructive criticisms of advertisements prepared for him by his agent or copywriter. The ability to seize upon an incident which would pass many people by, and assess its true news value is a great asset to the advertising man. But there is a difference, and a very important difference, between the preparation of an article upon a certain machine and an advertisement upon the same machine for the same journal. The difference is that the article must be written to interest all, or at least a majority of the readers, while the advertisement need interest only those who can influence the purchase of it.

This very important difference is one which is frequently overlooked by manufacturers and their advertising men, when they endeavour to obtain editorial publicity, and it is this point which distinguishes the carefully thought-out article from the blatant puff which might have been lifted bodily from the advertising columns.

The more wealthy journals, of course, employ expert journalists to knock such contributions into shape, but there are many useful technical papers which cannot afford to employ the necessary staff, and in their case the editor either makes vigorous use of the blue pencil or reserves a page or so at the end of the paper where he can tuck away the puffs and so avoid giving offence to his advertisers.

A good ideal to set oneself is to resolve to send out nothing that would not stand at least a good chance of being accepted as a paid-for contribution or as a news item sent in by a staff reporter.

One should try to give the editor what he wants in the matter of quantity as well as in quality. I have met men who make a point of always sending to a paper at least twice as much matter as there is any hope of getting published because, as they say, "it is bound to be cut down, any way." It is usually only because an editor wants to make a review of plant complete that even the mangled remains of that man's copy get into the compositor's hands at all. It is, in fact, better to send matter which is too short. If it interests the editor, he will soon ask for further particulars. Then you must get a move on and see that there is no delay in furnishing the additional information.

In dealing with shows and exhibitions, one is sometimes handicapped by the fact that no changes of very great interest have been made since the previous year's exhibition, and on such occasions it is very easy to fall into the old lazy habit of dishing up the same old stuff again, but a little hard thinking often shows a way of introducing the old subject from a new angle without overstepping the very small space which is usually all that an editor can spare for each particular firm's exhibit. Full use, however, should be made of any change in design, even when the alteration is not sufficient to place the product in the category of something new.

The publicity man's duty does not stop at sending out his description. If possible, he should attend the exhibitions and meet the editorial representatives of all the journals he can. A little personal explanation always does good, and in any case it is a useful opportunity to meet and get to know the people whose goodwill you have to secure.

Never forget that a technical journal is a newspaper and, like all newspapers, it dearly loves anything in the nature of a scoop. It is therefore often desirable to give preference to the paper which is likely to be the most interested in your product. Let the editor have the information well in advance of other papers, so that he has a chance of being ahead of his contemporaries, and, whatever you do, do not let him down. Tell other people in your firm what you are doing, so that they do not let out the information to a less important journal before the time is ripe. I can imagine that there is nothing more annoying to an editor than to find that he is forestalled by one of his contemporaries.

IRON AND STEEL PRODUCTION.

IT is reported by the National Federation of Iron and Steel Manufacturers that there were seventy furnaces in blast at the end of December, the same number as at the end of the previous month, two furnaces having gone in and two out of blast. Production of pig iron amounted to 330,600 tons, compared with 296,400 tons in November and 349,800 tons in December, 1930. The production includes 86,500 tons of hematite, 128,200 tons of basic, 96,000 tons of foundry, and 15,200 tons of forge pig iron. The December output of steel ingots and castings amounted to 422,400 tons, compared with 459,200 tons in November and 337,200 tons in December, 1930. The December output figures bring the total for the year to 3,758,100 tons of pig iron, compared with 6,192,400 tons in 1930 and 7,589,300 tons in 1929, and of steel to 5,175,600 tons, compared with 7,325,700 tons in 1930 and 9,636,200 tons in 1929.

The following table shows the average monthly production of pig iron and steel ingots and castings in 1913, 1920, 1928 to 1930, and the production in each month since December, 1930 :—

	Pig iron. Tons.	Steel ingots and castings. Tons.
1913—monthly average	855,000	638,600
1920—monthly average	669,500	755,600
1928—monthly average	550,800	710,100
1929—monthly average	632,400	803,000
1930—monthly average	516,000	610,500
December	349,800	337,200
1931—January	337,200	402,200
February	318,200	486,400
March	357,100	500,100
April	323,200	397,400
May	346,500	435,100
June	323,800	428,900
July	317,000	428,700
August	275,700	357 300
September	248,200	400,500
October	284,200	457,400
November	296,400	459,200
December	330,600	422,400

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

BRITISH LOCOMOTIVE DESIGN.

SIR,—Referring to the article by Mr. W. A. Tuplin on "The Trend of British Locomotive Design," in your current issue, it should be noted, as a historical fact, that William Stroudley, locomotive engineer to the London, Brighton and South Coast Railway from 1871 to 1889, designed his engines to work at extremely early cut-offs.

In his classic paper, read before the Institution of Civil Engineers, he states that the cut-off could be reduced to 12 per cent. "with excellent results"—"Proc.," Inst. C.E., March, 1885—and his "Gladstone" class of express engines, while in their original condition, were habitually worked with cut-offs in the neighbourhood of that figure.

ERNEST F. SMITH.

Dunfermline, Fife, February 6th.

PROFIT-SHARING IN INDUSTRY.

SIR,—I do not know whether Mr. Wickham Steed made any reference to it, but I have yet to find any writer who does not ignore the greatest experiment of modern times and, one might almost add, the greatest failure, in attempting to find industrial peace by a profit-sharing agreement between capital and labour.

I refer to the 1921 agreement in the coal industry, of which the Report of the 1925 Coal Commission says (page 132) :—" . . . it is a new and striking attempt to get back to an automatic determination of wages by reference to ascertained facts. The old sliding scales, based on selling prices only were open to obvious criticism; selling prices are an inadequate test of economic conditions, in so far as they do not allow for changes either in the costs of production or in the volume of trade. The 1921 agreement provided accordingly for the ascertainment, district by district, of the actual gross proceeds of the industry in a given period, *i.e.*, the money received on the sale of coal and of the costs of production other than wages; of the difference between these two sums, described as net proceeds, a certain proportion was to be treated as the share of labour . . . "

Under this agreement of 1921 the net proceeds were divisible in the proportion of about 85 to labour, 15 to the industry, as giving it an economic return out of which to provide for both dividends and development.

This division was arrived at in consultation with economic experts, on a review of the working of the industry over a long period. Under pressure from the miners' leaders the proportion was in 1924 altered to 87/13, thus reducing the economic return to the industry.

The agreement provided that if labour's share of the net proceeds should be insufficient to pay agreed minimum wages, the balance must be made up by the owners out of their supposed share. The ascertainment was to be made from the mineowners' books by independent accountants appointed by the men and owners respectively and mutually agreed, thus removing the reproach of secrecy which has been so fruitful of ill-feeling in industry. The agreement of 1921—to quote the Report of the 1925 Commission—"was hailed, not only in this country, but by expert observers overseas, such as the United States Coal Commission, as a landmark in progress to better relations between employers and employed." . . . "The outstanding merit appeared to be that it . . . made the wage in form, what it is in substance, a sharing of the proceeds of the industry. The mineowners, who were mainly responsible for suggesting the form of the agreement, deserve every credit for their readiness to make this new departure, and to open their books for impartial examination."

It should be noted that so soon as the net proceeds might be sufficient to meet minimum wages and also give the owners their agreed proportion, an increase in the pithead price of, say, 1s. per ton would benefit the men by about 10½d., the owners by 1½d.

It is true that the agreement was found to leave loopholes for discontent in the matter of selling prices by collieries to associated concerns, and it soon became clear that the ratio of the division was to be a question of dispute, but these and other points might be capable of adjustment from time to time, without destroying the basic principle of profit-sharing. Why, then, did the agreement fail to bring peace, and rather may be said to have contributed to the strike of 1926 ?

Briefly because the minimum wage demanded absorbed the whole of the net proceeds, or more. Certainly the agreement provided that if the men's share of 85 per cent. should be insufficient to pay minimum wages the balance made up by the owners out of their supposed 15 per cent. should be treated as a debit, to be repaid in better times when the men's agreed share might be more than sufficient to pay agreed minimum wages. But in fact it has been generally found impossible for the owners to recover many millions of pounds which they have had to find out of their supposed share of the proceeds, and the industry has never received its economic return.

In short, the profit-sharing agreements of 1921 and 1924 in the coal industry broke down in 1926 because there were no profits to share, and one of the parties refused to share losses. Any such agreement, in which minimum wages are pegged too high, is bound to break down in bad times.

From my own experience of wage negotiations since 1926 I venture to say that the agreement has in effect merely introduced a number of additional points for dispute. Except for the remarks which I have quoted from the Report of the 1925 Commission, the mineowners have never been given credit for their attempt to bring peace to their industry, and I submit the facts set forth above to the consideration of those who write, often too confidently, that a profit-sharing principle in itself will ensure the peace that industry so much requires.

They may find other reasons than I have suggested for its breakdown, but at least in their consideration of the whole subject they should not ignore this particular and remarkable experiment. J. G. H. WARREN.

Bath, February 6th.

P.S.—The quarterly statistical returns published by the Mines Department (price 1d.), give, for each district, the cost of wages, cost of production other than wages, selling prices, and credits or debits per ton of coal sold —a complete economic vivisection of the industry.

J. G. H. W.

Ball Bearing Manufacture.

IN a paper before the Junior Institution of Engineers on January 22nd, Mr. Wilfrid Fish stated that ball and roller bearings had reduced the coefficient of friction as compared with plain bearings to one-tenth. Modern processes of manufacture were practically the same throughout the trade, the principal feature being the great accuracy maintained in all the dimensions of a ball bearing, the balls being correct to one-ten-thousandth of an inch, the tracks of the inner and outer races being paired to a similar accuracy, while on other dimensions a limit of one-thousandth was maintained. Since their introduction fifty years ago, many changes had taken place in the method of manufacture. Originally, the balls were manufactured from bar, and after the parting-off pip had been removed by hand were rumbled, hardened and put into commission. Other methods were tried, but all, in addition to being costly, left the fibre of the metal uneven on the surface of the blank. Cold heading had been found to give the best results as it closed the fibre and produced a blank with a minimum of "flash." Chrome carbon steel wire in coils was used, and the heat treatment to which it had been subjected to make it suitable for cold forging must not decarburise the surface of the wire. The cold-heading machine sheared off the desired length of wire and introduced it between a pair of hemispherical dies operated by a crank mechanism which compressed the "slug" to form a ball—the wire diameter should be two-thirds that of the finished ball plus a small allowance for finishing and grinding. For balls over 1in. diameter the steel was heated and a press took the place of the cold-heading machine. The output from the heading machine varied between 3600 and 12,000 per hour for ⅜in. diameter to ⅞in. diameter balls respectively.

Before hardening the balls, Mr. Fish continued, were rough ground, and it was in this and similar operations which followed that the accuracy commented upon was obtained. It depended on two factors, one that the removal of metal was extremely slow, and the other that a large number of balls was being operated on and receiving the same treatment at once, making the slow operation a commercial proposition. The grinding was done between large vertical discs having annular grooves on their faces to receive the balls, one disc of iron being stationary while the other disc carrying a grinding wheel revolved. An aperture was arranged in the fixed disc through which the balls were introduced from a hopper and another to receive the ball after it had passed once round the disc, falling thence into a mixing chute and going back to the hopper, from whence it again entered the disc, but in a different groove. The operation was continued for some hours until all the balls were ground to a uniform size, leaving only sufficient metal for final grinding after hardening. Hardening was done in a revolving tube with an internal spiral and the balls were then discharged into a quenching bath. The grinding after hardening was done on the same principle, except that the grit and grade of wheel were finer. The balls were thus reduced until they were between three and four-ten-thousandths over size. That final small amount was very simply and yet efficiently removed by tumbling in a steel barrel with paraffin and rouge until all signs of grinding scratches had been removed and the balls were reduced to the required size. A final polish was given by tumbling in a wooden barrel, dry, with leather cuttings.

The manufacture of ball races and housings was described, the operations involving, in accordance with usual practice, a gradual removal of metal in a sequence of operations, the limits worked to being gradually reduced as the metal to be removed decreased. In grinding the internal track the radius was not now produced by means of a formed fixing grinding wheel, but by a wheel, the radius of whose edge was less than the radius of the track, and by oscillating the head carrying the wheel between definite points whilst the grinding of the race proceeded.

THE Prime Minister has appointed Professor Sir Thomas Hudson Beare, University of Edinburgh, to lead the British Government delegation at the first International Congress of the International Association for Bridge and Structural Engineering, which is to take place in Paris from May 19th to 25th, 1932. The other British delegates are :—Professor R. V. Southwell. F.R.S., University of Oxford; Mr. C. S. Chettoe, Ministry of Transport; Mr. J. W. Spiller, one of the Chief Engineers for the Crown Agents for the Colonies; and Major R. F. Maitland, secretary of the Institution of Structural Engineers. The International Association for Bridge and Structural Engineering has been formed to promote international co-operation among scientists, engineers, and manufacturers, and to make possible the interchange of knowledge, ideas, and the results of research work in the sphere of bridge and constructional engineering in general. For this purpose congresses are to be held at intervals of from three to five years.

The Mechanism of Electric Locomotives.*

By J. D. TWINBERROW, M. I.Mech. E.

(*Continued from page* 155.)

DETAIL OF MECHANISM.

Nose-and-Axle Hung Motors.—The main line of the South African Railways between Pietermaritzburg and Glencoe contains inclines of 1 in 50 extending for continuous lengths up to a maximum of 17 miles, with numerous curves of 500ft. radius. There is also a loop line where the gradients are 1 in 30, not compensated for the curves, of which the minimum radius is 300ft. Traffic conditions necessitated the working of through freight trains of the maximum tonnage permitted by the strength of the draw-gear, of wayside freight trains, of local and of through express passenger trains. The required schedule could be maintained without exceeding a speed of 45 m.p.h.

It was found that the service could be given by the adoption of a unit of 1200 H.P. used singly for the lighter trains, two or three being coupled and operated in multiple to give 2400 H.P. and 3600 H.P. as the complete engine for the through trains. The length of the rigid wheel base was to be limited to about 9ft. The control equipment and the drivers' cabs required a body length of about 40ft., provided that the motors were located beneath the floor.

Motors of 300 H.P. each could be fitted between wheels of 4ft. diameter with the required clearance above rail level. The distance between gear centres was insufficient to permit of the application of quill shafts with universal driving gear, and no alternative to the quill as a support for the spur wheel was then in existence. Rod drives applied to four-wheel bogie trucks were making poor records, so that the nose-and-axle support of the motor was adopted.

The nose of the motor is carried in a bracket which plays vertically in guides fixed in the transom, under the control of rubber springs. These serve to cushion the changes of torque, but they do not modify the angular momenta generated by the impact due to the play of the bearing springs.

Connecting and Coupling-rods.—The severe gradients on the electrified main lines of the Great Indian Peninsula Railway are concentrated in a length of about 15 miles, where the escarpment of the Western Ghats is surmounted by continuous inclines of 1 in 40, with a maximum of 1 in 37. The freight engines were required to haul maximum tonnage trains through the coastal belt and to mount the gradient with the assistance of a similar banking engine. They were also required to act as pushers for the ascending passenger trains at a maximum speed of 35 m.p.h., and to control both freight and passenger trains by regeneration of energy on the down gradient. The design was also affected by the customary flooding of the track to a depth of about 18in. for several days in each year during the monsoon. The damp conditions which precede the breaking of the monsoon rendered it very desirable to avoid the loss of adhesion due to the reaction of torque on the leading axles of individually driven groups. These considerations led to the adoption of two groups of six-coupled driving wheels, driven by inclined connecting-rods from a jackshaft with twin motors carried high in the frames.

The assembly of the rods is given in Fig. 13, a detail of the big-end of the connecting-rod in Fig. 14, and of the forward length of coupling-rod in Fig. 15. The pin which unites this rod to the trailing part is turned with an excentricity of 0·08in., so that by rotation in its bearings the length is adjustable to the extent of 0·16in. The forked end of the coupling-rod engages deeply with the nose of the triangular rod in order to ensure lateral stability when allowing the middle axle to play laterally. The bush for the little-end is carried in a spherical seating in order to eliminate cross binding when the superstructure rolls through a small angle. The rods are bushed with mild steel lined with white metal. The outer ends are sealed by aluminium caps. The only case of trouble in running was due to the working out of a little-end pin, due to defective locking.

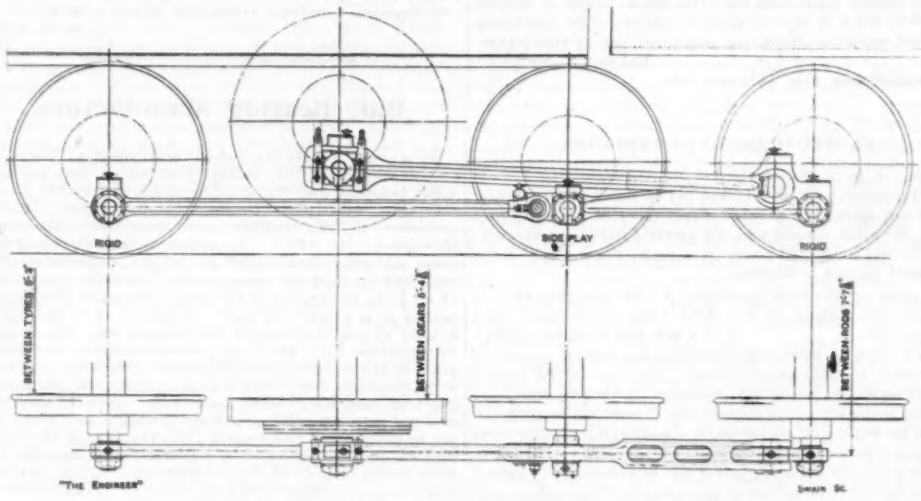


FIG. 13—COUPLING-RODS FOR FREIGHT LOCOMOTIVES

Individual Axle Drive.—Each high-speed locomotive has three driving axles, independently driven through a universal connection, which permits of radial, angular, and lateral displacement of the centre line of the driven with respect to that of the driving shaft. The connection thus embodies the leading features of the Hooke joint and of the Oldham coupling with the addition of endwise play. The angular displacement involves a cyclical change in the angular velocity, but in practice, even when the driven axle is mounted in a bogie truck, the angle is so small that the resultant variation is inappreciable, especially when the driving gears have a spring mounting.

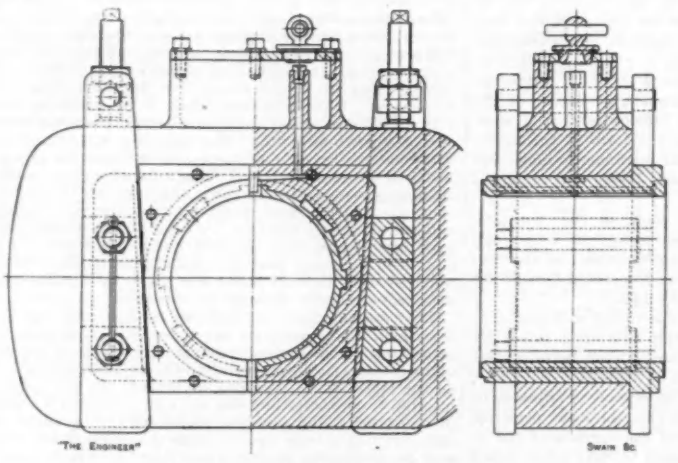


FIG. 14—CONNECTING-ROD BIG END

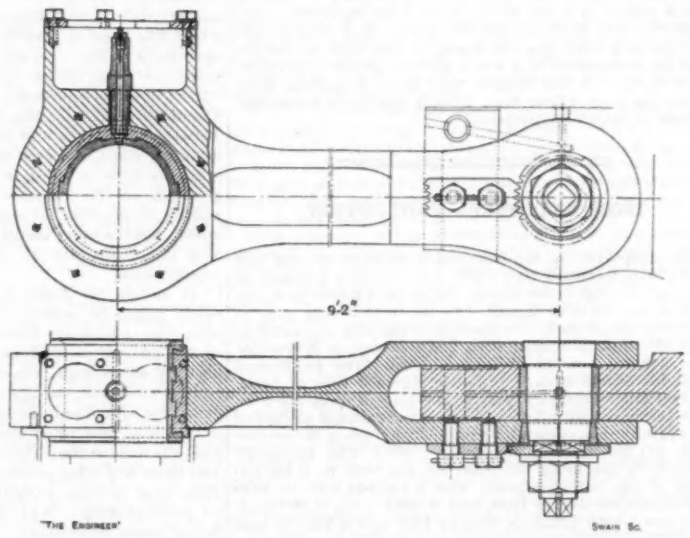


FIG. 15—OUTER END COUPLING-ROD FOR FREIGHT LOCOMOTIVES

Winterthur Gear for Class $\frac{E\,A}{1}$.—In the class of locomotive produced by the Metropolitan-Vickers Electrical Company, of which twenty-two are in service, numbered 4003 to 4024, the gear is applied centrally, as in Fig. 16. A cross arm is keyed to the middle of the axle, and at each end it is fitted with rectangular slide blocks on a spherical bearing. The blocks slide in guides formed radially in a floating ring. On a diameter at right angles with the arm, the floating ring carries rectangular blocks which slide in radial guides formed in the discs which support the rim of the main spur wheel. Each disc is formed with a hollow trunnion bearing through which the axle passes with ample clearance for all movements. The trunnions run in bearings, the upper parts of which are carried in the main frame stay casting and the lower parts are supported by the removable bottom gear case.

Each axle is driven by two motors placed in tandem across the locomotive immediately above each pair of driving wheels. The vertical distance between the centre line of the trunnion bearings of the spur wheel and those of the armature shafts is too great for the admission of single-reduction spur gearing. It has, therefore, been necessary to introduce an intermediate shaft. This is provided with a central pinion in mesh with the main spur wheel and flanked at each side with a wheel driven by a pinion on the adjacent armature spindle. An oil pump with two opposed plungers is driven by gearing from each end of the intermediate spindle. The oil is delivered under pressure to the bearings of this spindle, and to the trunnion bearings immediately below. The oil flowing from the inner end of the bearings is conducted to each moving part of the universal gear and to the teeth of the spur wheels. With a view to greater simplicity the oil pumps were omitted from the later engines. The gear teeth were made to lift the oil to reservoirs above the second motion shaft, the circulation being completed by gravity and centrifugal action. The rim of the main spur wheel runs on bronze strips screwed to the periphery of the supporting discs, the angular movement being controlled by six sets of short helical springs with pivoted follower plates. When such springs are inserted under ample initial compression the time of oscillation may be made variable, the periodicity changing with the amplitude.

Oerlikon Gear for Class $\frac{E\,B}{1}$.—The motors on the General Electric Company's locomotive "No. 4001" are arranged in pairs between the frames. The twin casings support the bearings for a hollow shaft or quill which surrounds the axle, as in Fig. 18. To one end of the quill is keyed a spur wheel with a spring-mounted rim meshing with a pinion on each armature shaft. At the other extremity of the quill there is a cylindrical casing which encloses a universal driving connection. The casing is fitted with guides at the opposite ends of one diameter to receive the slide blocks mounted on a floating member. This member is built up of two forgings in the form of a four-sided figure. It is fitted with pins to carry the slide blocks at two opposite angles, and the other two angles are provided with spherical bushes to engage with short connecting-rods, the opposite ends of which are coupled to spherical bushes on the ends of crank pins, which project inwardly from the wheel centre. The plunger of an oil pump is connected to the floating member at each end of its longer diameter, in line with the guides. The body of the pump is secured to the periphery of the casing and the stroke depends upon the excentricity of the axle with respect to the quill. These centre lines are displaced initially to the extent of ¼in., and the amount of the throw is increased by the vertical movement of the axle in the hornblocks. The oil is forced through suitable connections to all working parts. The crank pins enter the casing through apertures which are closed by spring-loaded sliding plates having a spherically seated packing ring around the body of the pin, thus retaining oil and excluding flood water.

One wheel of each pair is directly driven, the tractive effort at the tread of the opposite wheel being developed through torsion in the body of the axle.

It will be noted that this arrangement of driving gear necessitates the employment of outside framing.

Buchli Gear for Class $\frac{E\,C}{1}$.—The driving mechanism of the Brown, Boveri locomotive is shown by Fig. 17. This is also applied directly to one wheel only of each pair, but the main spur wheel is mounted externally, so that the two crank pins in the driving wheel project outwardly, and the locomotive is built with inside framing. The motors are arranged in pairs between the frames and above each axle at such a height that the armature spindles project outwardly above the wheels, being supported in outboard bearings attached to a steel casting which embraces the upper portion of the driving wheel and spur gear. The three supports are united into a continuous structure. Each main casting carries a fixed trunnion on which the spur wheel rotates. The crank pins fixed in bosses in the driving wheel project through apertures in the disc of the spur wheel where they are connected to the parallel links of the Buchli driving gear. The ends of the links are provided with spherical bushes in order that they may swing transversely with the end play of the axle. Each link is coupled to the outer end of a lever mounted on a trunnion pin. The inner ends of the levers are meshed

* The Institution of Mechanical Engineers—Jan. 29th, 1932.

THE MECHANISM OF ELECTRIC LOCOMOTIVES

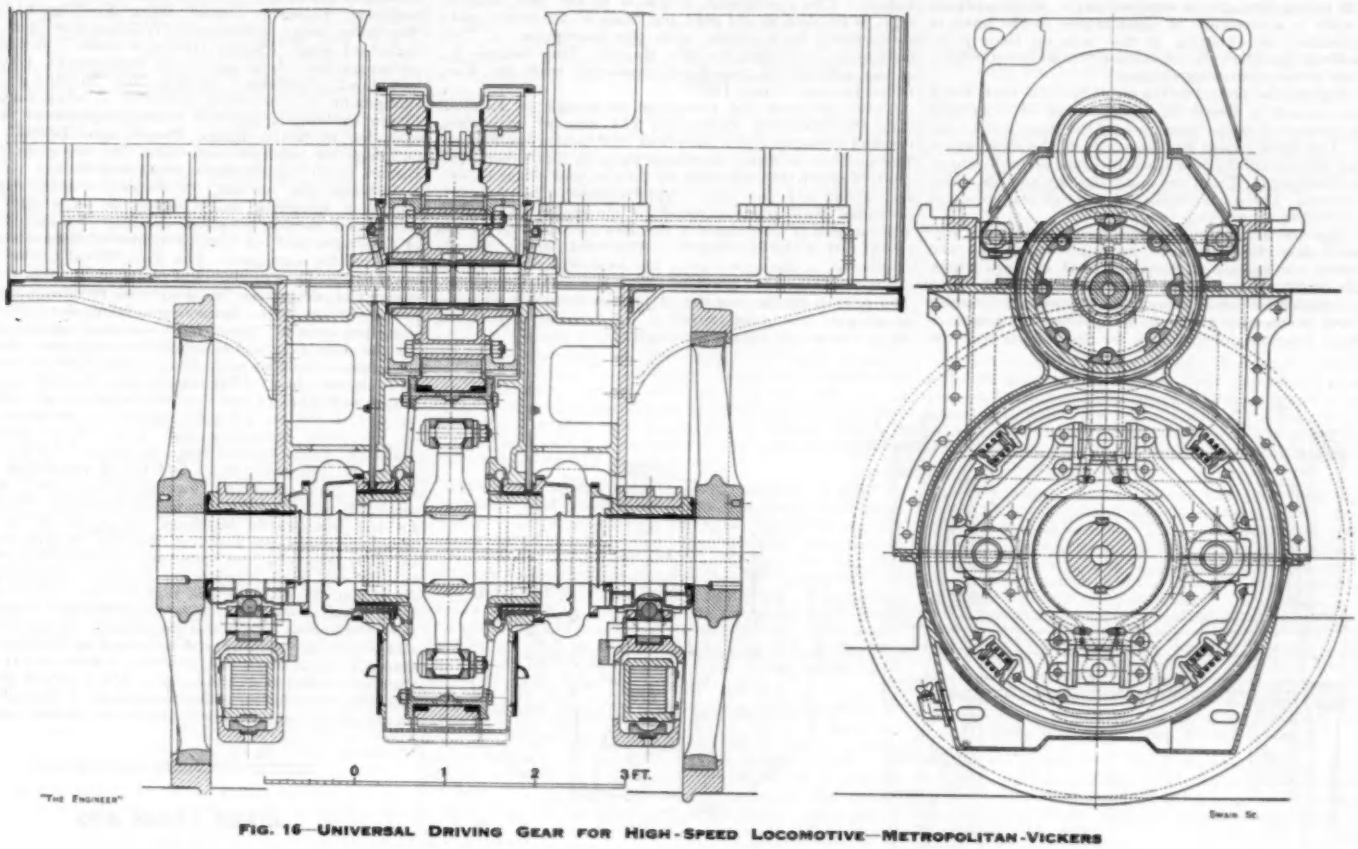


FIG. 16—UNIVERSAL DRIVING GEAR FOR HIGH-SPEED LOCOMOTIVE—METROPOLITAN-VICKERS

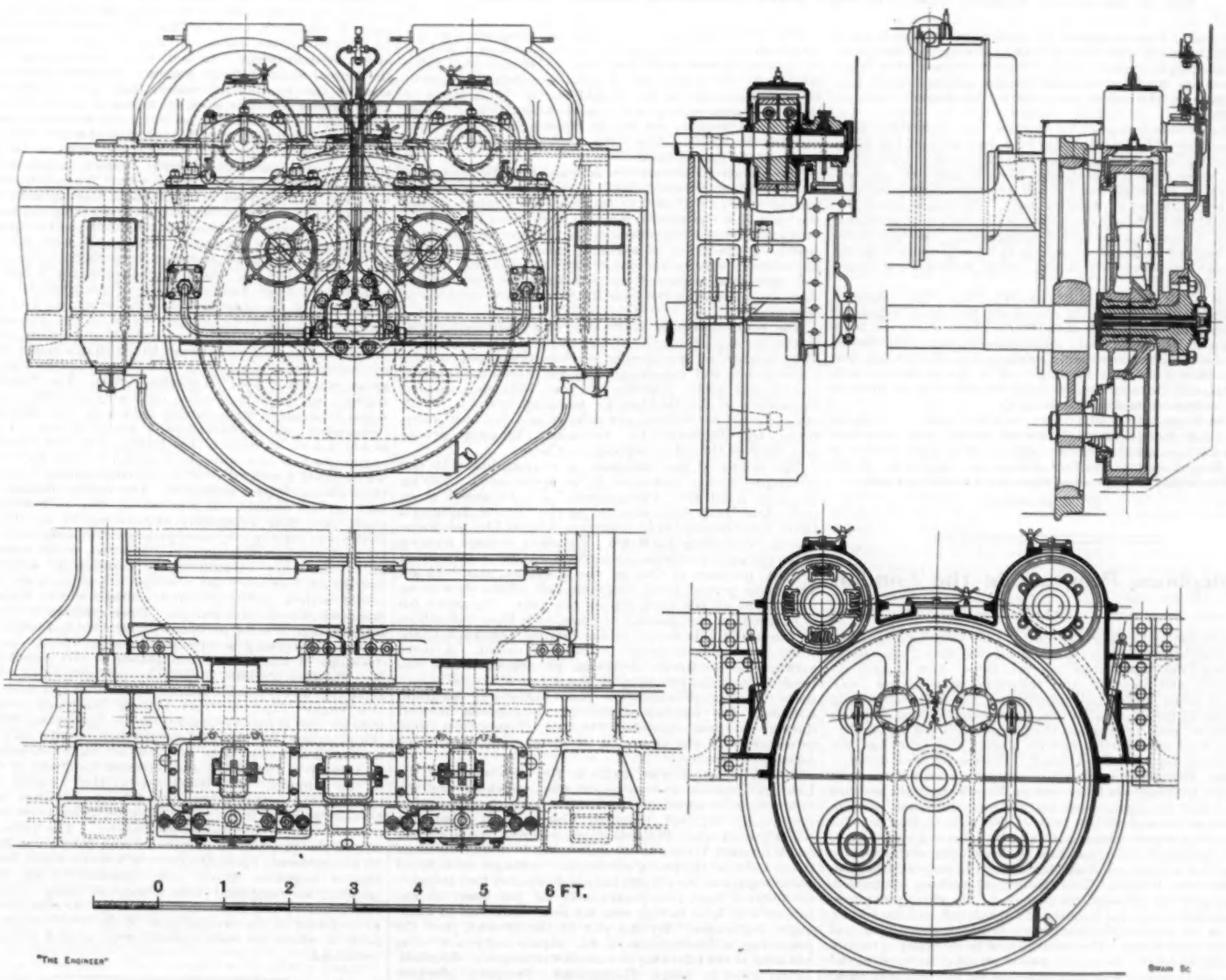


FIG. 17—UNIVERSAL DRIVING GEAR FOR HIGH-SPEED LOCOMOTIVE—BROWN, BOVERI

together by means of toothed segments. The levers are thus mutually locked when there is an equal and opposite force exerted in each rod by reason of the transmission of the torque. Any displacement of the axle in a direction parallel to the links superposes an equal force at each end of the levers which are then free to move, the toothed segments rolling through the required angle. Displacement of the axle in a direction at right angles to the links is accommodated by swinging of the links on their pins. Both actions take place simultaneously for all intermediate directions of the relative movement.

An oil pump is bolted to the outer face of each fixed trunnion, which is bored for the passage of a driving spindle connected to the inner face of the boss of the spur wheel. The oil is raised by the teeth of the spur wheel from the bottom of the gear case to sumps at each side of the main castings. These are connected by suction pipes to the pump. The oil is circulated through the trunnion bearings and to all working joints.

Framing.—The inside frames of locomotives Nos. 4003–4024 are closely spaced in order to reduce the width over the flanges of the three steel castings which form the bodies of the gear casing, in addition to providing a very complete system of bracing. Between the buffer plates and the castings the framing is of box construction, with inner longitudinal members for the reception of the draw gear. These members are so arranged that automatic central couplers with friction draw gear may be substituted for the draw hook and springs when convenient. The bogie frames are made with inside frame plates braced and stiffened by the cross bars and by horizontal stretcher plates.

The outside frames of locomotive "No. 4001" are reinforced above the driving axles by a deep strip of ¾in. plate extending from the top of the horn gaps to the upper edge. The lower edge of the frame plate is stiffened by 4in. by 4in. by ¾in. angle bar of which the continuity is ensured by the bolting up of the horn stays. The bogies are of the Adams type with flat pivots, cross slides with spring control, inside framing and inverted springs with equaliser bars. The bogies were made to conform as far as possible with the standard requirements of the Indian railways for steam locomotives.

The inside framing of locomotive "No. 4002" consists of steel plates, 1¼in. thick, spaced 4ft. 8in. apart to receive the motors. The depth of the frame plates above the horn is limited by the necessity for clearing the armature shafts, but the structure is strongly reinforced on the driving side by means of the gear housings and on the equipment side by the self-contained character of the structure supporting the resistances and switch groups.

The bogie trucks which have a wheel base of 9ft. have the inside framing strongly braced by the cross members and by horizontal stretcher plates. The bogie trucks of the freight engines are braced from end to end by plates which shield the motors and equipment from flood water.

(To be continued.)

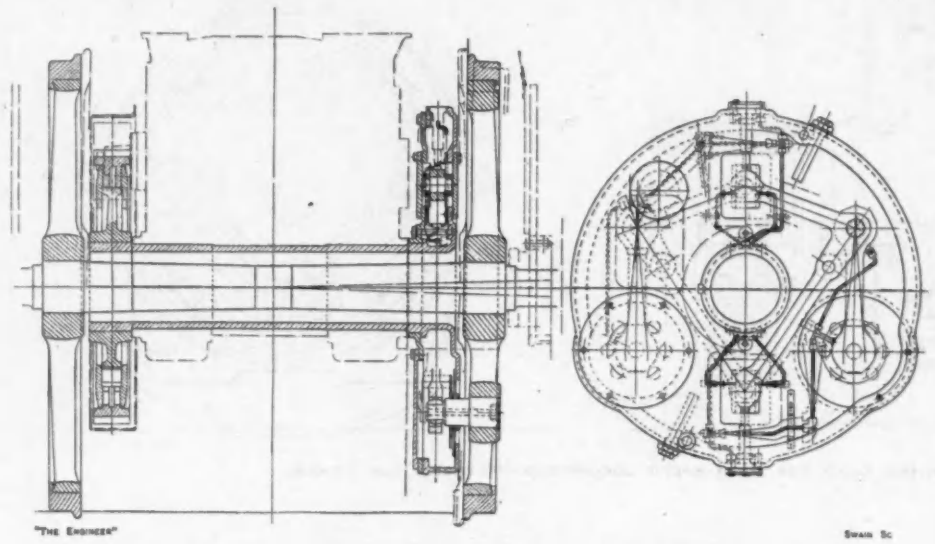


FIG. 18—UNIVERSAL DRIVING GEAR FOR HIGH-SPEED LOCOMOTIVE—GENERAL ELECTRIC

Telephone Progress in the London Area.

ACCORDING to the statement of 1931 telephone progress in the London area, just issued by the Post Office, during the past year special steps were taken to develop and improve the telephone system, not only by securing additional subscribers, but by accelerating the provision of installations, improving the long-distance services and increasing telephone facilities generally. The most noteworthy feature during the year was the introduction of "On demand" service for long-distance calls. This was introduced in connection with the service to the Birmingham local area on November 28th, and has been greatly appreciated by users of the trunk service. Between 80 and 90 per cent. of the calls to Birmingham are now completed while the caller remains at his telephone. Arrangements are in hand for the extension of this service to other towns, including Manchester, Liverpool, Glasgow, Leeds and Bristol. This method of working eliminates, in practically all cases, the period of time which previously elapsed between the booking of a trunk call and the setting up in its turn of the connection between the calling and called subscribers. The caller is now being asked to remain in circuit while the call is passed straight forward to the distant exchange and the connection set up. The switching equipment used for this service is of a new type and has many special features designed to accelerate the service and improve the quality of speech.

A point of special interest marking a stage of the development of the service is that in June, 1931, the 2,000,000th telephone to be installed in this country was accepted by His Majesty the King for use in Buckingham Palace. The instrument, which is of the new handset type, is finished in old gold and bears a decorative plate surmounted by a crown with the inscription: "This instrument, installed for His Majesty King George V., is the 2,000,000th telephone connected with the Post Office system—June, 1931."

There are now 154 telephone exchanges in London, viz., 36 automatic exchanges, 114 manual exchanges, two toll exchanges, and the trunk and tandem exchanges. The number of direct exchange lines on December 31st, 1931, was 426,000, the increase for the year being 16,800, *i.e.*, about 4·1 per cent. Approximately 28 per cent. of these lines are connected to automatic exchanges. The number of telephones in the area increased by 27,500 to 731,000 at the end of 1931. The total number of calls originated in the area during the year was 681 millions, the increase over the previous year being about 2 per cent. The growth in the number of private branch exchanges continued, the total number in London now being 30,887, of which 138 are automatic.

The Transatlantic service was in frequent use for broadcasting purposes, and in this connection a feature of special interest was the series of twenty-four talks broadcast last spring and relayed simultaneously from 300 radio stations in the United States. This series of talks was arranged by the Travel Association of Great Britain and Ireland, and was an effort to attract a record number of tourists from the Dominions and United States to the British Isles.

The quality of the service afforded to subscribers was continuously reviewed by means of the service testing system. Over 190,000 tests were taken during the year and the results indicate that there has been a further all-round improvement in the service. In pursuance of the policy of assisting subscribers in securing an efficient service on their own installations, nearly 100 operators employed by subscribers in their offices were trained during the year in the standard methods of operating.

The total operating staff—day and night—employed in the London exchanges at the end of 1931 was 10,800. The number of engineering workmen engaged in the construction and maintenance of the London telephone system was 8500. During the year 1552 men availed themselves of the facilities for technical training, which are provided at various polytechnics and technical institutes, the Department's Automatic Training School and the Post Office Correspondence Classes.

The utility of the telephone in conjunction with the telegraph service continued to be appreciated. During the year 2,400,000 "Phonograms," *i.e.*, telegrams given in by telephone, were received at the Central Telegraph Office, and the number of telegrams delivered by telephone was approximately 1,200,000. The daily average number of telephonically addressed telegrams was 930, representing a daily increase of 200 on the previous year's figure. Telegrams passed from telephone call offices showed an increase of 40 per cent. during the year. No trunk fee is charged for the passing of these calls from call offices within a 100-mile radius of the Central Telegraph Office when provincial telegraph offices are closed. A more expeditious treatment of foreign phonogram traffic has resulted from the provision in March last of special equipment in close proximity to the Continental telegraph circuits. The number of foreign phonograms handled during the year exceeded 810,000. Typewriters were introduced for the reception of phonograms with very satisfactory results.

Steady progress was made in the conversion of the London telephone system to automatic working, and the following new automatic exchanges were opened during the year:—Gulliver (Kentish Town area), Gladstone (Cricklewood area), Pollards (Norbury area), Leytonstone and Whitehall. Within the 10-mile radius from Oxford-circus there are now thirty-six automatic exchanges with fitted accommodation for 178,860 lines and capacity for extension to 300,000 lines. Approximately 32 per cent. of the subscribers' lines in this area are now connected to automatic exchanges. By the end of the present year the percentage will be increased to 44. Equipment is now being installed at the following automatic exchanges:—Southall, Acorn (Acton area), Hampstead, Prospect (Barnes-Richmond area), Perivale, Byron (South Harrow area), Bayswater, Merton Abbey, Mayfair, Regent, Grosvenor, Langham, Hither Green, Tulse Hill, Colindale, Wordsworth (Kenton area), Bethnal Green, and Bowes Park.

Arrangements are in hand for the installation of automatic equipment at Terminus Exchange (King's Cross area), and new buildings are in progress for the following automatic exchanges:—Addiscombe (extension of existing building), Valentine (Ilford area), Kensington, Arnold (Wembley area), Larkswood (Walthamstow and South Chingford area), Plashet (Plaistow area). New manual exchanges have been opened at Sanderstead, Ewell and Downland (Coulsdon, Hooley and Merstham areas). Equipment is now being installed at Chislehurst and Pinner exchanges, and the existing equipment is being extended at Seven Kings, Barnet, and Redhill. New buildings for manual exchanges are being erected at Epsom, Elmbridge (Surbiton area), and Purley.

Although the amount of electrical energy expended during a telephone conversation is extremely small, the amount used in telephone exchanges for the operation of apparatus and for various incidental purposes is very large in the aggregate. The Post Office is one of the largest consumers of electrical power in London, the total amount of energy used for the postal, telephone, and telegraph services in the London area being about 20 million units per annum. Apart from electrical equipment used for the operation of 150 telephone exchanges, the plant maintained includes over 500 electric light installations, 130 electric lifts, 2700 electrically lighted telephone kiosks and cabinets, the majority of which are controlled by electrically wound time switches, ventilating plant in telephone exchanges and post offices, pneumatic despatch tubes, calculating machines, electric motor transport, telegram, letter and parcel conveyors, stamp vending and cancelling machines, mail bag cleaning machines, and a variety of miscellaneous plant. Electricity for the headquarter buildings and some of the larger telephone exchanges and post offices is taken at pressures up to 11,000 volts and transformed in the Department's sub-stations to the various low-tension voltages required. At G.P.O. South the extra high-tension sub-station has been reconstructed, and a new installation is now practically complete which will provide for the needs of the new telephone building now in course of erection on the Queen Victoria-street site, as well as for the G.P.O. South. Current is taken at a pressure of 11,000 volts and provision has been made for an ultimate demand of 1000 kVA with an estimated annual consumption of 1,500,000 units.

SIXTY YEARS AGO.

NOT very much was known in this country sixty years ago concerning the detailed practice of American locomotive engineers. The reason for ignorance on that subject was given in our issue of February 16th, 1872, and to the modern reader must appear to be a curious one. It resided in the fact that until recently American locomotive builders did not trouble themselves very much about their drawings. In fact, many first-class firms in the United States did not possess a complete drawing of any of the locomotives which they had constructed. They carried out their work by means of sheet iron templates and of wooden rods on which the principal dimensions were laid down. This rough-and-ready style of construction was stated to enable the work to be put together with sufficient accuracy. Great advances had been made in this respect within recent years, but, so we recorded, an American set of working tracings still contained much too little information concerning details to satisfy the inquiring English engineer. Photographs and wood cuts of American locomotives were familiar in this country, but of drawings, properly so called, very few had reached us. As a consequence, the belief was widely held that American locomotives were all very much cast in the same mould. The belief, we said, was in part well founded. In the States it was impossible to find a difference of types analogous to that which existed in this country between Mr. Stirling's huge outside cylinder express engines, and the Great Western's broad-gauge engines of the "Waverley" class. The American railway engine was almost invariably a four-coupled bogie locomotive with outside cylinders, bar frames, a cowcatcher, and a characteristic design of cab. Yet it would not do to believe that having seen one American engine we had seen all. As regarded details, there was, we recorded, a wider diversity of practice among American than among British engineers. The family likeness was only on the outside. It was wrong, too, to believe, as many did, that locomotive engineering in the United States was making very slow progress compared with that being shown by this country. There was, at the moment, an intense desire in existence to improve the American locomotive, and every day novelties in practice were being tested with a pertinacity and courage which, we said, deserved to meet with success. These remarks formed an introduction to some particulars which we laid before our readers concerning a typical American goods engine, drawings of which had been placed at our disposal by Mr. Thatcher Perkins, locomotive superintendent of the Louisville and Nashville Railway. The drawings show that this engine departed from typical American practice, in so far that it had six coupled wheels, but it possessed the characteristic bar frames, cowcatcher, ornate cab, tall decorated chimney, large steam dome, sand box and bell on the top of the boiler, and immense headlamp in front of the chimney. The boiler was of the "wagon top" type and the springs of the three driving axles were united by compensating levers. The main regulator valve was of the now familiar double-seat piston form. The valve gear was of the Stephenson pattern driving flat valves, but in its arrangement it presented several features which we said English engineers would find remarkable. The spark arrester, we suggested, was worthy of being copied in this country, and there were distinctly valuable features to be found in the arrangement of the crosshead guides, both of which for each cylinder were placed above the crosshead.

Railway and Road Matters.

THE Southern Railway has ordered forty-four electric motor coaches for the Brighton and Worthing electrification scheme. They are to be supplied by the Metropolitan-Cammell Carriage Wagon and Finance Company, Ltd., and by the Birmingham Railway Carriage and Wagon Company, Ltd. The order is based on extended trials which have been carried out during the past few months on the Southern Railway with specially built test coaches.

AT the annual meeting, on Wednesday, February 10th, of the Institution of Railway Signal Engineers, it was reported that sixty-five new members had been elected during the year. As there had been a loss of twenty-nine, the net result was an advance in the total membership from 788 to 824, of whom 243 are resident overseas. The new President is Mr. Charles Carslake, the assistant signal and telegraph engineer, Southern Area, London and North-Eastern Railway.

THE London, Midland and Scottish Company has recently built at Wolverton some new sorting vans for the travelling Post Office, in which particular attention has been paid to the comfort of the staff. Over the sorting tables a twin fitting for the electric light has been provided in order to reduce shadow effect, and there are hot-water irons and ovens for warming food. In the event of a failure of the electricity in one van a supply can be switched in from an adjoining vehicle.

ONE of the most difficult bridge repairs on the L. and N.E.R. will be made between 6 p.m., on February 20th, and 8 p.m., on February 23rd, when the renovation of Selby Swing Bridge is taken in hand. More than two hundred passenger trains will have to be diverted whilst the work is in progress. Repairs are to be effected to the two end cross girders, and the main girder ends of the swing span, whilst one of the fixed spans is to be entirely replaced. Electric welding will be used.

WE regret to hear of the sudden death on February 2nd of Mr. W. P. Reid, who was the locomotive superintendent of the North British Railway in succession to Mr. Matthew Holmes, from 1904 to his retirement, on reaching the age limit, at the end of 1919. Mr. Reid was the father of Mr. R. W. Reid, formerly the Carriage and Wagon Superintendent of the Midland, and then of the London, Midland and Scottish railways, and afterwards a vice-president of the latter company, whose own lamented death took place in April, 1929.

DRAWING our attention to an article in our issue of January 29th last, in which it was stated that the speed of 23 m.p.h. attained by the Armstrong-Whitworth oil-electric rail-car was "5 miles per hour faster than that of any self-propelled vehicle previously run over the route," the Sentinel Waggon Works, Ltd., informs us that on September 30th, 1930, a 200–250 H.P. "Sentinel-Cammell" double articulated steam rail-car, having twice the seating capacity of the car in question, on the same gradient, maintained an average speed of approximately 22 m.p.h.

FOLLOWING up the note in this column on January 22nd as to garages at railway stations, we note that in *The Times* of that date appeared a letter which pointed out that if adequate garage accommodation were provided at stations many people who now drive 50 or 60 miles to town would travel by rail. The motor car can beat the train only by reducing delays at the beginning or end of the journey. From a subsequent letter from Major Stenson Cook, it appears that the Automobile Association published in August last a booklet of garages at railway stations in the London area, and that the demand for the book showed how interested motorists were.

FOR the new electrical services between London and Brighton and Worthing, Mr. Maunsell has designed a bogie specially to ensure smooth riding at the highest speeds. The motor coaches will have a driver's compartment and a guard's and luggage compartment. Next to the latter, also at the other end of the carriage, will be a vestibule entrance to the passenger accommodation, which will be of the saloon type, divided into two by a partition and having a central corridor. Removable tables can be placed between each pair of seats. To deaden sound, cork slabbing is secured to the steel floor plating, and linoleum is laid over the cork, with sponge rubber strips down the centre corridor. There are large side windows operated by balances.

A NEW departure in the use of containers was officially inaugurated by Sir Josiah Stamp at Euston the other day. The household furniture removal business, from one town to another, has hitherto been in the hands of removal contractors, whose loaded vans used to be transported intact on a truck by rail. Latterly, however, the contractors have used motor vans and have themselves taken them by road, from door to door, throughout. To meet this competition the London, Midland and Scottish Company has developed a furniture removal business, whereby it not only provides containers in which to pack the household effects, but furnishes all the labour for loading and unloading. One hundred such containers are being built and the demonstration at Euston was to show how effectively the railway company could deal with the business. The notices in the Press that resulted from this exhibition have led to the Rev. Reginald B. Fellows, the historian of the Canterbury and Whitstable Railway, writing to *The Times* of February 6th, to say that the report, dated July 18th, 1833, of that railway company said that "carriages of a new description for merchandise are building, whereby goods will be transmitted from the ship (at Whitstable) to their destination in Canterbury without being shifted in the interval." We would also have it remembered that such carriers as Suttons used to pack their consignments for individual towns and send them as a whole. The railway companies objected and the Great Western ineffectually carried a case against Suttons, wherein it was alleged that they were not goods "of the same description" as laid down in Section 90 of the Railways Clauses Consolidation Act, 1845, to the House of Lords. Then, when, in 1882, the Post Office introduced the parcels post, containers were used. They formed a prominent feature in the scheme of the late Mr. A. W. Gattie.

Notes and Memoranda.

ONE cannot escape the suspicion, says Mr. R. Ricardo, that the extensive use of very large Diesel engines at sea is due, as Sir Alfred Ewing suggested recently, "rather to the taste and fancy of some dominating personality than to a careful weighing of arguments such as appeal to engineers." I fancy, he says, the next few years will show a reversion to steam in the larger and faster classes of shipping.

IN building a reinforced brick arch bridge near Philadelphia, by a cantilevering process, the used mortar was of a rather unusual mixture. It consisted of two parts high-early-strength Portland cement, one part natural cement and six parts of sand. This mortar proved entirely satisfactory, giving a strength at the end of twenty-four hours sufficient to allow the use of the work under load. The natural cement was used to give plasticity and workability to the mix.

BENZYL cellulose is now being put into production by Imperial Chemical Industries. The possibilities of this new plastic are enormous, and so far as can be seen there is hardly a single British manufacturing trade to which it will not be potentially of value, owing to its unique chemical and electrical stability, its impermeability to moisture, its non-inflammable nature, and the ease with which it is worked. The electrical properties of benzyl cellulose are excellent, and since it is unaffected by ozone there is a wide outlet for it in some parts of the electrical industry where rubber rapidly perishes.

FINE cracks in metal which are too small to be seen by the naked eye can, according to *Canadian Machinery*, be detected by the following method:—The metal surface should first be cleaned and then painted with a thin mixture of red lead and petrol. In a few minutes the petrol will have evaporated, leaving the red led on the surface. This should be wiped off with a dry cloth. The surface should then be examined through a magnifying glass. If a crack exists a thin red streak will be seen in the metal. This streak will be caused by the red lead, which was carried into the crack by the petrol, and was therefore not wiped off with the remainder.

ON January 1st, 728 vessels, of a total tonnage of 1,966,417 net, were laid up at ports of Great Britain and Ireland, an increase of 373,170 net tons, or 23·4 per cent., compared with January 1st, 1931, but a decrease of 123,026 net tons, or 5·9 per cent., compared with October 1st last. The figures for January 1st include ten foreign vessels of 20,340 net tons, so that the British tonnage laid up in British ports on that date consisted of 718 vessels of 1,946,077 net tons, representing over 3,000,000 gross tons, or about 4,500,000 deadweight tons. The figures do not include British shipping laid up in foreign ports. Among the British vessels laid up are sixty tankers, of 232,603 net tons, of which seventeen, of 70,769 net tons, are motor ships. In addition, fourteen other motor ships, of 40,968 net tons, and thirteen sailing vessels, of 1892 net tons, are laid up.

WRITING to *Power*, Mr. H. M. Spring says: "In electrical installations proper attention is frequently not given the location of fuse blocks in regard to temperature. A speed-control box for an automatic stoker in one plant was mounted against the brickwork on the side of the furnace walls. The main leads to the stoker motor ran through fuses inside of this box. Some time after the plant was placed in operation and the boiler was operating at a high rating the fuses blew out several times. It was apparent that something was wrong. The electrical connections were checked and found not to be at fault. Then the engineer discovered that the temperature of the fuse box was around 120 deg. Fah., due to the heat conduction through the furnace wall. This temperature was sufficient to cause the fuses to open at full load. The control box was removed and several sheets of insulating material were put between it and the wall, after which there was no further trouble."

IN the course of his Howard Lecture before the Royal Society of Arts, Mr. R. Ricardo said: "It is my confirmed belief that the Diesel engine of the future will be a small, high-speed unit of a size which can be turned out very cheaply by bulk production methods, and that where large power concentrations are required, we shall employ large batteries of such units. We must, however, revise also our ideas as to how such engines are to be handled. The large slow-running engine is far from self-supporting—it requires sympathetic care and constant attendance; the high-speed engine requires none of these things: in fact, there is nothing whatever that the most conscientious or sympathetic attendant can do to minister to its needs. So long as it has oil and fuel it will run, for its lubrication is entirely automatic, and whether tended with skill or neglected, it will continue to run for a similar period until wear or carbonisation brings that period to a close. Experience will soon show just how long it is economical to allow any particular make of engine to run between overhauls."

AN invention for reclaiming naphtha fumes and converting them into liquid naphtha has been installed at the Windsor Mill, Hollinwood, of Alfred O. Ferguson and Co., Ltd., indiarubber waterproofers. After a week's trial the results are regarded as very satisfactory. Naphtha fumes which previously affected the workpeople and were eventually given off into the atmosphere are now utilised commercially. The result is a purer atmosphere and better working conditions. The principal of the firm is reported to have told a *Manchester Guardian* representative that £700 had been spent in ventilating the proofing room. Each proofing machine has a large tube through which the fumes are drawn to tanks outside the works. There the naphtha fumes are absorbed by carbon, which, when subjected to steam, gives off the naphtha. This is separated from the water and the liquid naphtha returns through the pipes to the works ready for use again. At these works four to five thousand gallons of naphtha are used each week, the price of which is 1s. 2d. to 1s. 6d. a gallon. It is stated that the plant, which is driven by two motors, is very easy to supervise, and that the overhead charges are small.

Miscellanea.

THE foundations of a twenty-two-story skyscraper have been laid in Moscow. The building is destined for the Book House. Hitherto the highest building in Moscow has been only thirteen stories.

ANOTHER coal-handling plant is to be put up at Dover for dealing with coal transported by rail. There are to be a truck tippler, conveying belts and a telescopic shoot for dropping the coal into ships' holds.

A RETURN just issued by the Ministry of Transport shows that during last year the passenger journeys on the tramways of Great Britain decreased by 4·75 per cent., while those on trolley omnibuses increased by 20·04 per cent.

A NEW type of oxy-acetylene welding blow-pipe has been brought out by the Linde Air Products Company, of New York. In this blow-pipe two adjacent flames are used, one to pre-heat the welding rod almost to welding temperature, and the other to perform the actual welding. It is said to work about twice as fast as an ordinary blow-pipe.

IT is, according to the *British Russian Gazette*, now definitely ascertained that the large deposits of shungite lying within the confines of the Karelian republic can be exploited as fuel. The experiments of the State Institute for Applied Chemistry have established that under special conditions shungite burns well and can be widely used as fuel in Leningrad industry.

A NEW petrol-electric rail car has been built by the Ottawa Car Manufacturing Company, Ltd., for the Canadian Pacific Railway. It weighs 68¼ tons when empty and has an overall length of 74ft. Power is supplied by a 400 horse-power engine and generator connected with two 250 horse-power motors. The maximum speed of the car is said to be 75 miles per hour.

AN agreement has been signed between the Chinese Ministry of Railways and the Board of Trustees in charge of the British Boxer Indemnity Refund for a loan from the latter of £400,000 sterling, for the construction of a railway ferry across the Yangtze River, connecting Pukow with Hsiakwan, Nanking, the materials for which will, it is said, be imported from Great Britain.

A NEW extension to the Toilet Laundries, Ltd., in Montreal, Canada, is nearing completion and will represent the first windowless structure of modern design in Canada, according to an item published in the *Canadian Engineer*, November 17th, 1931. In the building will be installed equipment for complete purified air control and for controlled air temperature at 68 deg. to 70 deg.

THE Supreme Court of Utah held on January 23rd that the use of hand labour instead of machines on a public project results in substantial increase in the cost of the project and therefore is unconstitutional. The Court granted a writ of prohibition stopping Salt Lake City from proceeding with the construction of a 600,000-dollar storm sewer on a minimum-wage, hand-labour basis, holding that the programme violated a section of the Constitution which specifies that money appropriated for one purpose cannot be diverted to another purpose.

THE Standing Committees of the American Society for Testing Materials will hold their annual Spring Group Committee meetings in Cleveland, beginning Monday, March 7th, and extending through Friday, March 11th. In conjunction with these is the third regional meeting sponsored by the Society, which will be held on Wednesday, March 9th. An important objective of the programme is the dissemination of accurate information concerning rubber and its products among those outside the rubber industry, so as to aid engineers in applying rubber products to their particular needs and to assist in the preparation of proper specifications.

THE third international life-boat conference will meet in Holland during June on the invitation of the two Dutch life-boat societies. The meetings will be held in Amsterdam, and the delegates will also visit Rotterdam. Among the countries whose life-boat services will send delegates are Great Britain, the United States, France, Germany, Italy, Spain, Sweden, Denmark, Belgium and Portugal. It is interesting to note that the conference will be conducted in English. Mr. Barnett will read a paper on "Recent Developments in the Motor Life-boats of the Royal National Life-boat Institution," and Captain Bremner on "The Institution's High-speed Petrol Engine Installation."

AN innovation in the proceedings of the Institute of Metals is being made by the Council in connection with the forthcoming annual general meeting of the Institute, to be held in London on March 9th and 10th. While the ordinary business of the Institute and the reading of papers will occupy the first day and the morning of March 10th, the second afternoon's session will be devoted to a general discussion on "The Testing of Castings," which will be opened with a short paper by Dr. W. Rosenhain, F.R.S., F. Inst. Met., a past-president of the Institute. Visitors are invited to take part in the discussion. Cards of invitation admitting to the meeting may be obtained on application to the secretary, Mr. G. Shaw Scott, M.Sc., F.C.I.S., 36, Victoria-street, Westminster, S.W. 1.

THE Department of Overseas Trade has issued a revised edition of the guide to the services which it offers to United Kingdom firms interested in the development of export trade. A foreword is contributed by Major John Colville, the Minister in charge of the Department, who appeals to every trader, large or small, to extract the fullest possible benefit from the services placed at his disposal, and affirms his intention to continue the work of the Overseas Trade Development Council, to which he attaches great importance as a means of tackling specific problems and assisting the expansion of the export trade generally. The booklet is divided into sections relating to standing information, commercial news, economic surveys, the British Industries Fair, and the overseas organisation of the Department.

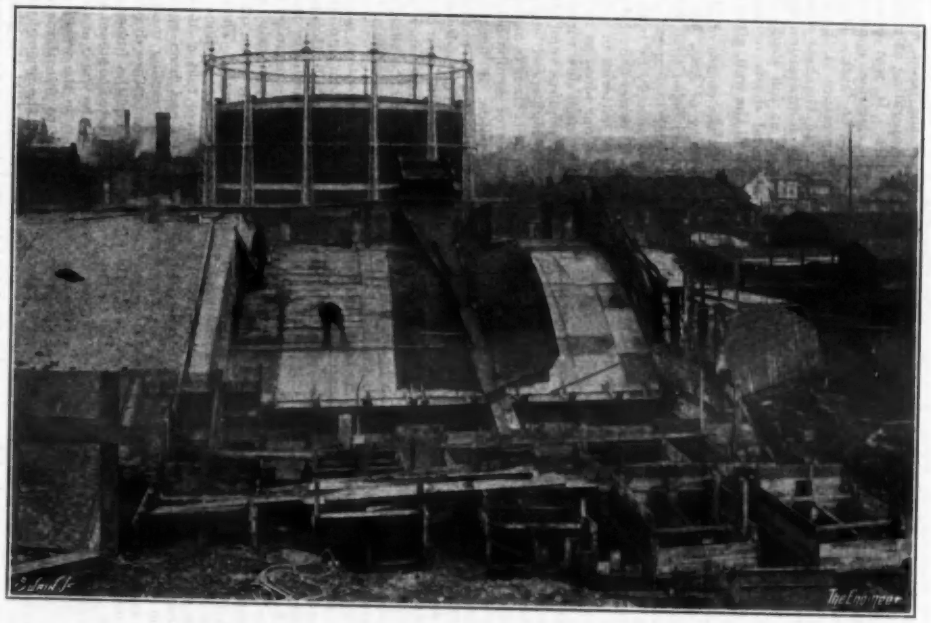
L. AND N. E. RAILWAY—NEW BRIDGE OVER NORTH CIRCULAR ROAD, MIDDLESEX

MR. C. J. BROWN, M. INST. C.E., LONDON, ENGINEER

(*For description see page 178*).

CENTERING FOR CONCRETE ARCH

CONCRETING MAIN ARCH



CONCRETING MAIN ARCH

CONCRETE ARCH NEARING COMPLETION

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Contents.

THE ENGINEER, February 12th, 1932. PAGE

A SEVEN-DAY JOURNAL .. 173
THE EROSION OF STEAM TURBINE BLADES. No. II. (Illus.) .. 174
AIR POLLUTION IN 1930-31. (Illus.) .. 176
NEW RAILWAY BRIDGE OVER THE NORTH CIRCULAR ROAD. (Illus.) 178
INSTITUTION OF MECHANICAL ENGINEERS .. 180
PUBLICITY IN THE EDITORIAL COLUMNS .. 180
IRON AND STEEL PRODUCTION .. 181
LETTERS TO THE EDITOR—
British Locomotive Design .. 181
Profit Sharing in Industry .. 181
BALL BEARING MANUFACTURE .. 181
THE MECHANISM OF ELECTRIC LOCOMOTIVES. No. II. (Illus.) .. 182
TELEPHONE PROGRESS IN THE LONDON AREA .. 184
SIXTY YEARS AGO .. 184
RAILWAY AND ROAD MATTERS .. 185
NOTES AND MEMORANDA .. 185
MISCELLANEA .. 185
LEADING ARTICLES—
Protection and Progress .. 187
The International Aeronautical Position .. 187
LITERATURE .. 188
BOOKS RECEIVED .. 188
MOTOR CAR TRANSMISSION. (Illus.) .. 189
MARKETS FOR INTERNAL COMBUSTION ENGINES .. 190
INSTITUTION OF CIVIL ENGINEERS: MANCHESTER ASSOCIATION 190
OPEN-SIDED PLANING MACHINE. (Illus.) .. 191
MERCURY SWITCH ON-LOAD TRANSFORMER TAP CHANGING GEAR. (Illus.) .. 191
A NEW PUNCHING AND CROPPING MACHINE. (Illus.) .. 192
A SMALL GEAR PUMP. (Illus.) .. 193
CANADIAN ENGINEERING NOTES .. 193
BORE-HOLE PUMPING PLANT. (Illus.) .. 194
SOUTH AFRICAN ENGINEERING NOTES .. 194
PROVINCIAL LETTERS—
The Midlands and Staffordshire—Lancashire—Sheffield .. 195
North of England—Scotland .. 196
Wales and Adjoining Counties .. 197
CATALOGUES .. 197
LAUNCHES AND TRIAL TRIPS .. 197
EDUCATIONAL INTELLIGENCE .. 197
CURRENT PRICES FOR METALS AND FUELS .. 198
FRENCH ENGINEERING NOTES .. 199
BRITISH PATENT SPECIFICATIONS. (Illus.) .. 199
FORTHCOMING ENGAGEMENTS .. 200
CONTRACTS .. 200

NOTICES TO READERS.

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PROTECTION AND PROGRESS.

A FEW days ago the long and insistent demands of industry were granted; but naturally it is not satisfied. It has now a tariff indeed, but not Protection. The 10 per cent. *ad valorem* duty on all goods—with few exceptions—is, in fact, no more than an announcement to the world that the United Kingdom has ceased to be a Free Trade country. In due course, it may raise duties to ten times the present nominal figure. If the purpose is entirely to exclude certain foreign products, a very high tariff will in many cases be necessary. But if the purpose is to allow the foreigner just to keep his foot in our market, so that a revenue may be secured by the sale of his goods, then a smaller, but nicely balanced, figure will have to be found. We imagine that the Advisory Committee which is to be set up will find itself on the horns of a dilemma; on the one side, the Chancellor of the Exchequer, on the other, industries. The former will, inevitably, tend to look upon tariffs as a source of income, whilst the latter will insist upon complete Protection. To direct the best course between those opposites will demand astute handling. At an early date the Government will have to define its policy in that respect. The constitution of the Committee which is to fix the import duties will be awaited with interest and some anxiety. The decision that it shall be a small one is admirable; but it makes the selection of the right men, and particularly the right chairman, all the more difficult. There has been a good deal of talk about a Scientific Tariff. The term is a little vague, but it means, no doubt, a tariff so adjusted that it will give the maximum benefit to all the industries of the country. Such a tariff cannot be found in a week or a month. If action is to be taken quickly, something less perfect will have to serve for a time.

We have observed a tendency to concentrate attention on the development of the home market by Protection. That is, of course, the primary and obvious purpose of import duties. But it is easy to exaggerate its importance to a country like ours which must always rely in large measure upon its overseas trade. A time may come when Great Britain will form part of an Empire united as the States of America are united. In that day, the arrival of which may be accelerated by the new change of policy, we shall not have to concern ourselves overmuch with the competition of foreigners; the Empire will be almost completely self-satisfying. But for the present we have to seek trade in all the markets of the world, and in so doing we have to compete with other European nations, which are able to produce more cheaply than we can. The real problem before us is the reduction of manufacturing costs. It is hoped that behind a tariff wall we shall be so able to extend our scale of manufacture by the expansion of home business that, on the familiar principle that costs fall with increase of output, we shall be in a position to challenge foreign prices. We sincerely hope it may be so. But there is a long way to go. It would be idle to suppose that tariffs, and tariffs alone, can avail us. The margin between our prices and foreign prices is too high to be countered by the reduction of on-costs; the reduction of labour charges is equally essential. That might be achieved by re-adjustment of wage rates, if it were not probable that the result of the tariff will be to increase the cost of living. The alternative is to curtail the relative proportion that labour occupies in production. The old formula for engineering costs was: One-third for material, one-third for on-costs, one-third for labour. In the course of years those proportions have been somewhat modified, but they are probably not very far wrong for general engineering at the present day. In some industries the proportion occupied by labour is very much less, and it is those industries which are able to sell at competitive prices. The motor car industry is a striking example. In it, despite high wages, labour may represent no more than 15 per cent. of the total manufacturing cost. The result is the cheap car. That has only been made possible by mass production, as, it is claimed, a direct outcome of the McKenna Duties. Will the protection of the iron and steel industry have the same effect? Will it enable us so to reduce the amount of labour per ton of product that we shall be able to make our prices approximate to those of Czechoslovakia or Belgium? Or, to look at it from the other side, if we cease to take millions of tons of steel a year from the Continent, will the prices of foreign steel be driven up by the reduction of output? These are interesting questions to which answers cannot easily be given.

The latest returns show that the number of unemployed is approximately two and three-quarter millions. That is a slump figure aggravated by a seasonal decline, but, as far as one can see, there is very little likelihood that the United Kingdom will ever get back to the prosperity of pre-war days when unemployment was a negligible percentage. That was due in part to our excellent overseas trade and in part to old methods of manufacture. The former has fallen as the result of inevitable causes, and improved methods of manufacture have reduced the demand for labour. Hence we are left with the probability, amounting almost to a certainty, that a large percentage of labour will always be unemployed. There we have the bugbear which harasses industry. To reduce costs we must reduce labour; but the reduction of labour means more money spent on "doles." The course which was once so plain is no longer clear. Yet we think that the wisest plan is to adopt every labour-saving appliance, whatever the proximate result may be. In the end, the most economic method of production is the best. Behind our new wall we must put our house in order. The costs of production must be lowered, and since it is impossible for us to bring our wages down to the level of those paid in competing European countries, we shall be compelled to reduce the proportion of labour in the total cost. There is no alternative. If we cannot do that, we may save the home market, but we shall not restore our foreign trade.

The International Aeronautical Position.

Two statistical returns published almost simultaneously during the past few days enable us for the first time to obtain a fairly complete general view of the aerial strengths of the principal aeronautical Powers. One of these returns is that prepared for the Disarmament Conference of the League of Nations, and gives particulars of the Service aircraft possessed by nine European countries, the United States, and Japan. The other, drafted by the British Directorate of Civil Aviation, gives particulars of the civil aircraft and civil flying organisations of sixteen European nations. If the Service figures submitted to the League of Nations can be accepted as trustworthy—they have already been criticised in some quarters in that respect—the two sets of figures, taken together, enable us to study the aeronautical position in a number of important countries, simultaneously from the Service and the civil point of view. Naturally, the information published concerning the civil machines is much fuller than that given in the returns of Service aircraft submitted to the League of Nations. Concerning the civil side we are told not only the total number of machines owned in each country, but are given such particulars as the number of pilots, engineers, and wireless telegraphists employed on regular air transport duties, details of the mileage flown, the power equipment and carrying capacity of the machines, and other intimate information. On the Service side the information made public is confined to the number of first-line machines, first-line reserves, and second-line machines possessed by the countries making the returns. Beyond what is implied by these figures, we are taken behind the scenes only to the extent of being given an estimated figure for the percentage of new machines included in each country's total. Age is certainly an important factor in assessing the significance to be attached to the number of machines possessed by any one country. So, too, are the type, power, and range of the machines making up the total; but on these points the League of Nations' return is silent.

Alike in Service and in civil machines, France, according to the returns, stands easily at the head of all the European aeronautical Powers, being credited with 3000 Service and 1188 civil aircraft. Which nation, Great Britain or Italy, comes second, it is a little difficult to decide. We are stated to possess 1434 Service machines to Italy's 1507, but the British figure does not include the craft belonging to the Auxiliary Air Force or those in India and the Dominions. In addition, on the civil side, we have 966 aircraft to Italy's 611. It may therefore be said that this country is either second or third among the European nations as regards Service aviation. Somewhat alarmist statements to the effect that we occupy fifth place may be discounted. They are based on the assumption that Italy is definitely ahead of us and on the inclusion of the United States and Japan in the list of countries compared. Our air policy since 1923 has been based on a scheme which includes defence against the air forces of other countries within striking distance of our shores. The United States and Japan may therefore, for the time being at least, be left out of the comparison. On the Service side Germany is, of course, by the Treaty of Versailles, debarred from possessing an air force, but on the civil side her widespread interest in aeronautics has now placed her, with 1065 machines, second to France. Our 966 civil machines give us third place in this category. That the four countries so far mentioned—France, Great Britain, Italy and Germany—should occupy leading positions in Service or civil aeronautics is only what one would have expected to find. Quite unexpected, however, is the Service strength credited to four of the minor European nations—Poland, Czechoslovakia, Jugoslavia, and Rumania, which constitute the "Little Entente." These four between them are stated in the League of Nations' return to possess 3110 Service machines. Any two of these countries could, on paper, rival in number the machines possessed by the Royal Air Force. If we are to believe a not altogether disinterested German critic, some of the figures in the return are open to suspicion. In particular, it is asserted that France and the minor nations under her influence have considerably exaggerated the numbers of Service machines in their possession in order that they may be able to meet, on paper, the wishes of the Disarmament Conference without hurt to their real position, and possibly even with benefit to it. In this connection it is perhaps significant to note that, judged by the standard of Great Britain, Italy, and Belgium, the four countries of the "Little Entente" are remarkably deficient in civil machines. According to the standard, we would expect to find, roughly, one civil machine for every two Service machines. Based on that ratio, Poland ought to have 350 civil machines. Actually she has only 147. Czechoslovakia, instead of having 344, has only 96. Jugoslavia, which claims 924 Service machines, should have 462 civil machines or thereabouts; actually, she has only 8. Rumania claims 799 Service machines. The number of civil machines which she possesses is not given in the Air Ministry's return, but one may reasonably doubt that it is of the order of 400. It may perhaps be added that for several reasons which might be given the ratio of the Service to the civil machines in the different countries might be

expected to show some rough approach to a uniform figure.

Civil aviation in every country of the world in which it is practised is still being carried on only with the active financial assistance of the Governments concerned. For example, in the British Air Estimates for 1931–32 the vote included for civil aviation amounted to £470,000. What, it may be asked, does the nation receive in return for that expenditure? In the early days, Government assistance to civil aviation was justified on the grounds that a civil side to flying would provide a reserve of machines upon which to draw in the event of war, just as the Navy could draw upon the mercantile marine; that it would establish a reserve of skilled pilots to supplement the regular air force during an emergency; and that it would help the aeroplane and aero-engine manufacturers to keep their works in employment. The returns, supplemented by a knowledge of the existing situation, show that the first and second of these reasons have largely lost any force which they may once have possessed. Restricting our attention to this country, we find that the number of machines possessed by Imperial Airways, the only aviation undertaking to which the Government pays a subsidy, amounts to a mere twenty, and that they are of types which in war would serve only for troop carrying and a few other minor non-aggressive purposes. Even although they were all of a type that could be readily converted for use, say, as bombers, their number would provide an insignificant addition to the 1434 Service machines on our establishment. Similarly, as regards *personnel*, if the whole flying staff of Imperial Airways were taken over the Royal Air Force would be augmented only to the extent of 35 pilots, 15 engineers, and 15 wireless telegraphists, and of that reinforcement, the pilots at least would be found in some important respects to possess qualities differentiating them from their Service brothers. There remains therefore only the effect of subsidisation on the aeronautical industry. The provision of machines and engines for Imperial Airways forms a useful but not extensive source of orders for British manufacturers. These orders have, however, obviated the industry's devoting itself exclusively to the production of military machines, and have placed it in a position to supply the needs of overseas countries with respect to civil air transport equipment. To what extent have British civil machines and engines been adopted by foreign air lines? The Ministry's return supplies a complete answer so far as the European countries are concerned. The regular air transport services in fifteen European countries—excluding Great Britain—are shown to employ between them 764 machines, which are equipped with 1271 engines. Of the machines, 25 are British; of the engines, 304 are of British manufacture or design. It would appear therefore that while British air transport machines are not in extensive use on Continental air routes, British civil aviation engines are very highly regarded, and are employed to the extent almost of one in four. To those who can recall the days when this country was wholly dependent on foreign aviation engines, the situation is distinctly gratifying.

Literature.

Estimating for Mechanical Engineers. By L. E. BUNNETT, A.M.I.P.E. London: Sir Isaac Pitman and Sons, Ltd. 1932. Price 10s. 6d. net.

THE subject of estimating is so important that it is somewhat surprising that more has not been published about it, and mechanical engineers will welcome a book written in their own language rather than in that of the accountant. The author has wisely omitted information which is readily available in numerous handbooks, and has sought to concentrate on describing correct methods of estimating, as well as to indicate some of the pitfalls ready to trap the unwary estimator, a man to whom, we are rightly told, common sense must be a *sine qua non*.

After stating that "estimating, in actual fact, is guesswork," Mr. Bunnett proceeds to claim that "the perfect estimator should be a draughtsman, a rate-fixer, and also something of an accountant, and a statistician," as well as being gifted with imagination! We feel that such a combination is not only unlikely to be found, but also that if obtainable would not furnish the ideal. We should prefer to state the case another way, and suggest that an estimator should be an engineer, trained both in the works and in the office, with a certain knowledge of cost accountancy and rate-fixing. The functions of rate-fixing and estimating are so distinct that a rate-fixer is not normally likely to make a good estimator. He will have been trained to make his work as exact a science as possible, and to reduce everything to the narrowed limits of time and price, so that eventually he will inevitably lack that breadth of vision essential to an estimator. We should like to see the line of demarcation between estimating and rate-fixing more clearly defined.

The whole subject is treated in a broad and logical manner, beginning with a discussion of general principles—Chapter I.—followed by notes on mensuration—Capter II. It is open to question whether the latter chapter might not have been omitted, as the information it contains is readily obtainable, but it is brief and certainly of value to students.

The important subject of labour is dealt with very clearly—Chapter III.—and a simple rate-fixing system is described. Some novel suggestions of the author are worthy of note. He is of opinion that "the first item of equipment which the rate-fixer should be given is a scale plan of the works, showing the width and height of doorways, gangways, &c.," and that this should be displayed on the walls of his office. We have visited a good many rate-fixing offices, but cannot recall ever having seen such a plan. The proposal to have diagrams of each separate shop, with the machines and their capacity clearly indicated, is a sound one, and should tend to reduce those visits to the shops which are prone to occupy so much of the rate-fixer's time. When fixing rates for articles that have never before been manufactured, the author would like the work to be actually undertaken by a member of the staff, whom he calls the "pioneer," and from whose performance he would assess the rate. We candidly doubt the wisdom of such an appointment, for not only would it tend to produce friction in the workshop, but it would be a serious reflection on the ability of the rate-fixing organisation. There is something to be said in favour of a man of this sort being held available to demonstrate the possibility of performing a job for a price which has already been fixed, when challenged so to do. Defective material and spoiled work cause the estimator much trouble; he must always take them into consideration, and we agree that it is very helpful to plot actual costs with a view to their serving as a guide in future estimates.

The investigation of speeds and feeds, and of labour of various kinds—Chapters IV. and V.—though primarily the concern of the rate-fixer, is a subject of great significance to good estimating, and is very usefully handled by the author. The selection of the right type of machine for the class of work contemplated is discussed, but the method suggested for determining whether work should be done, say, on a centre or turret lathe, is simple rather than exact, for the relative cost of the machines, of their maintenance, power consumption, &c., are all conveniently ignored.

Much valuable information is condensed in the section devoted to materials—Chapter VI.—but the subject of preparing a bill of materials is not alluded to, it being left for elucidation until the method of collecting the complete estimate is being explained.

That bugbear of the manufacturer, establishment charges, is briefly explained—Chapter VII.—and here we enter the domain of the cost accountant, who would be ready to criticise some of Mr. Bunnett's remarks. As, however, he does not claim to discuss the subject exhaustively, perhaps it is unfair to attach too much importance to his evident preference for a uniform rate of oncost for a factory. Simple as it may be from the estimator's point of view, we feel bound to emphasise its danger to a manufacturer who produces goods of great variety, for it will tend to load up one section of his works, while others will lament that they cannot hold their own with their competitors. A really good system of cost accountancy is not only essential to the modern manufacturer, but it is a great asset to the estimating department. Accordingly, we should have welcomed an assertion that it is axiomatic that cost accounting and estimating must be corelated, both being vital to the wellbeing of the concern. This goes much further than the liaison advocated by the author.

The manner in which complete estimates are built up is admirably described—Chapter VIII.—and the suggestions made for checking estimates are good. Estimating by interpolation and by weight, though admittedly crude, is most valuable as a rapid check to a considered estimate. It is desirable to arrange for finished weights to be furnished regularly to the estimating department, by whom curves can be plotted and useful information deduced. Perhaps there is no more vexed question in the estimator's office than what percentage should be added to cover contingencies, and here the experience of the estimator is invaluable.

Under the heading "Miscellaneous"—Chapter IX.—among other important considerations, the value of the judicious use of actual costs is stressed, and the necessity for carefully comparing these "actuals" with estimates is clearly demonstrated, and particularly with the adjustment of subsequent estimates in view. The form suggested for tabulating these comparisons is an excellent one, but its usefulness might be enhanced by including another column on both sides to show the cost of tools, an item for which the estimator frequently allows too little. We are in complete agreement with the author when he advocates "inquests" into bad estimates. They may involve much work, but it is time and money well spent. We also endorse the statement that "the art of forecasting the trend of prices cannot be learnt from any book, and the estimator should cultivate a broad outlook on current affairs in relation to their effect on his particular business."

Altogether "Estimating for Mechanical Engineers" is a work that should prove of great assistance to those for whom it has been written, and there are not many engineers who would not profit by a careful perusal of it. Mr. Bunnett has judiciously refrained from attempting to include detailed instructions in highly specialised trades, for, as he rightly says, "many excellent text-books are available for those who lack practical experience." References giving particulars as to the actual literature that has been published might with advantage be included in future editions.

Radio Telegraphy and Telephony. By RUDOLPH L. DUNCAN and CHARLES E. DREW. Second edition; revised and enlarged. London: Chapman and Hall, Ltd. 1931. Price 45s.

THIS is described as "a complete text-book for students of wireless communication." It is of American origin and deals with American practice, but it may be commended wholeheartedly to all students of any nationality who desire to master the rudiments of radio transmission and reception. It is extraordinarily thorough and painstaking, in some cases many pages being devoted to fairly simple matters, so that no doubt may be left in the reader's mind. Moreover, there is a good deal of repetition. One seems to see sometimes the separate hands of the two authors dealing with the same question from slightly different aspects. That adds to the bulk of the volume, which is great, but we are far from saying that it is not, on the whole, useful.

Whilst it cannot be said that the text-book is in fact "complete" as the authors describe it, for some of the subjects have been dealt with far more fully in other works, yet within its limitations it is amongst the best books on Radio for students with which we are acquainted. It begins at the beginning with the principles of electricity, discusses familiar laws and definitions, describes instruments and meters, and gives practical advice on such questions as the care of batteries. It then handles the elements of radio receiving and transmitting apparatus and shows how the various values of the components may be calculated. Much space is then devoted to commercial receivers and transmitters, which are fully illustrated and described. These are not the instruments of the home. The student who is thinking first of his private set will not, unless he is a "transmitter," find much in this section to interest him. It is meant for those who are going to make a business of radio, not for the amateur.

Here and there the British reader will find himself embarrassed by the American origin of the work, as, for example, the definition by symbols of "tubes" which appear to be more closely standardised in the United States than here, but he will not be offended by Americanese either in spelling or diction. The language is clear and simple throughout. We have only one complaint to make of it. The authors, like their opposite numbers on this side, are far to fond of the little word "due." One hesitates to remind them that "due" is an adjective, because custom seems to be robbing it of its prerogative; but if for no other reason than the avoidance of tautology, we suggest that a few "owing to's" might have been scattered through the pages, or that the all-pervading "due" might have been lessened by different constructions of the sentences.

BOOKS RECEIVED.

Angles on Practical Flying. By P. W. F. Mills. London Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C.4. Price 4s. 6d. net.

The Blue Book: The Electrical Trades Directory and Handbook, 1932. London: Ernest Benn, Ltd., 154, Fleet-street, E.C. 4. Price 25s. net.

The Combustion of Coal Dust. By A. L. Godbest and R. V. Wheeler. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 9d. net.

Brassey's Naval and Shipping Annual, 1932. Edited by Commander C. N. Robinson, R.N., and H. M. Ross. London: William Clowes and Sons, Ltd., 94, Jermyn-street, S.W. 1. Price 25s. net.

Plane and Geodetic Surveying for Engineers. Vol. I.: Surveying. Second edition. By D. Clark, B.Sc., M. Inst. C.E. London: Constable and Co., Ltd., 10 and 12, Orange-street, W.C. 2. Price 24s. net.

Mechanical Handling and Storing of Material. Fourth edition. By G. F. Zimmer, A.M. Inst. C.E. Two volumes. London: Crosby Lockwood and Son, Stationer's Hall-court, E.C. 4. Price £3 3s. the two volumes.

The Nile Basin. Vol. I.: General Description of the Basin, Meteorology, Topography of the White Nile Basin. By H. E. Hurst, M.A., D.Sc., and P. Phillips, D.Sc., B.A. Cairo: Egyptian Government Press. Price P.T.50 net.

Proceedings of the Thirty-fourth Annual Meeting of the American Society for Testing Materials. Part I., Committee Reports, New and Revised Tentative Standards, Tentative Revisions of Standards; Part II., Technical Papers. Philadelphia: American Society for Testing Materials, Pa., U.S.A.

Motor Car Transmission.*

By L. H. POMEROY.

THIS paper resolves itself into a disquisition upon the desirable attributes of a motor vehicle transmission and a technical description for the first time of the Daimler fluid fly-wheel transmission.

The instant we commence a discussion on the philosophy of motor vehicle transmissions, we go right to the fundamentals of motor vehicle design. In general, it may be said that he who settles the rear axle ratio of a motor car, settles once and for all its performance and even its commercial success. It is probably the outstandingly important decision which has to be made in the design of any conventional car.

As is well known, the orthodox sliding gear has been the object of contumely from the day thirty years or so ago that it was invented by Monsieur Panhard. His typically Gallic reply to his critics, "It is brutal, but it works," is classic. It was brutal, and it did work; and it is brutal now, and still works.

Anyway, the sliding gear in almost exactly its original form had an uninterrupted tenure of office till about three years ago, when one or two American concerns, casting around for novelties and wrestling with the mechanical engine difficulties arising from low rear axle ratios and high engine speeds, conceived the idea that a silent third gear and over-speed top would be a solution of their troubles.

In less than two years the "silent third" car makers found that the theory did not work, that although an acceleration from 0 to 30 m.p.h. in nothing flat could be obtained with a high maximum car speed and relatively low engine speed, this did not seem to cover the actual requirements of the driving public. The top gear ratio was reduced to what it was before the transmission experts got to work, the net result being the establishment in practice of the desirability of a silent third gear and an easy high-speed gear change.

In 1928—that year of clear financial skies and happy flotation memories—we saw the initiation of the free-wheel incorporated in the transmission line.

The free wheel, however, has not become popular, at any rate in this country, possibly because it reminded the occupants of a car at frequent intervals of the appalling noise of the average petrol engine.

On the other hand, the free wheel has been taken up vigorously by American makers during the past year. This can be safely put down to the necessity of attempting to dispose of a couple of million or so cars which were otherwise surplus to requirements, and, as is usual in such cases, something had to be done.

All these things, however, indicate a growing discontent with the established and conventional sliding gear-box. The public acceptance and desire for silent gears and easy changing is established, and with it has come for the first time in many years the diversion of the minds of engineering departments from engines to transmissions. Once again the field is set for the battle between various types of transmissions, but this time on a far more comprehensive scale than a generation ago. The obsolete epicyclic gear rises from its ashes to challenge the various combinations of sliding and constant-mesh gears, to say nothing of a number of miscellaneous types, such as the dynamo electric transmission, inertia torque converter, metal-to-metal friction, and other infinitely variable types.

In all that has been said so far, no mention has been made of an element in the transmission of almost equal importance to the gear-box, namely, the clutch. This is another component which on the grounds of suitability for its purpose only just gets by.

The transmission of a motor vehicle has to fulfil many functions. It needs to be efficient, silent, foolproof, and effortless in operation. It should allow the car to be driven in dense traffic with precision, safety, and the minimum of driving effort. It should also allow the car to develop its maximum speed and any desired variation of engine torque and car speed within the limits available. The author trusts that in a paper read before engineers, the condition of mechanical reliability will be assumed.

Considering these points in detail, that relating to slow-speed performance will be dealt with first, and its priority will probably not be disputed by experienced drivers. It brings into question the best means for obtaining the desired end. The specified condition of slow-speed performance applies, of course, to any gear from bottom to top. As a mental picture, climbing the Bull Ring in Birmingham on Saturday night should be sufficiently graphic. The orthodox transmission demands a very perfect clutch and good slow running of the engine for this sort of work to be done without intolerable anguish. It was a keen sense of the shortcomings of the ordinary clutch and gear-box that made the author readily receptive of any sound device to overcome them.

In 1926 Mr. Harold Sinclair, now managing director of Hydraulic Couplings, Ltd., brought along an invention relating to an hydraulic coupling, since acquired by the Daimler Company, which seemed to offer a ready issue out of all the afflictions which have been mentioned. This invention incorporated the Föttinger or Vulcan hydraulic coupling with a mechanical clutch in order to provide a means for definitely disconnecting the engine from the gear-box.

Several of these Sinclair couplings were made and fitted to cars with orthodox sliding gear-boxes, and operated perfectly under the condition of slow-speed operation now being discussed, and with the unique advantage of being able to bring the car to rest in traffic with the gears engaged so that driving became a matter of alternate accelerator and brake pedal operation.

It was, however, immediately obvious that with such a perfect means of coupling the engine to the transmission as was given by the hydraulic coupling, the presence of a mechanical clutch meant the perpetuation of an anachronism, and endless thought and ingenuity were expended in attempts to eliminate it and to obtain the desired "neutral" or free engine effect in the coupling itself. The history of these would make an interesting paper on the futility of attempting to defeat the laws of hydraulics.

During the period in which these investigations were proceeding, 1928–1929, the Daimler Company were developing an epicyclic gear-box and were receptive to the adoption of any meritorious epicyclic gear. Tests of the Wilson gear-box showed that whilst this was excellent as a gear-changing mechanism with fundamental features of mechanical superiority, it did not fulfil the slow-speed conditions of starting and running which had been established by the Sinclair patent.

At this juncture Mr. Percy Martin had the happy inspiration of combining a fluid fly-wheel with an epicyclic gear-box, thus multiplying the virtues of each, and the Daimler fluid fly-wheel transmission resulted. As now manufactured, it incorporates the Wilson gear-box, but it is not so limited. Fig. 2 shows a longitudinal section of the Daimler fluid fly-wheel, and Fig. 1 shows the form of the driving and driven members.

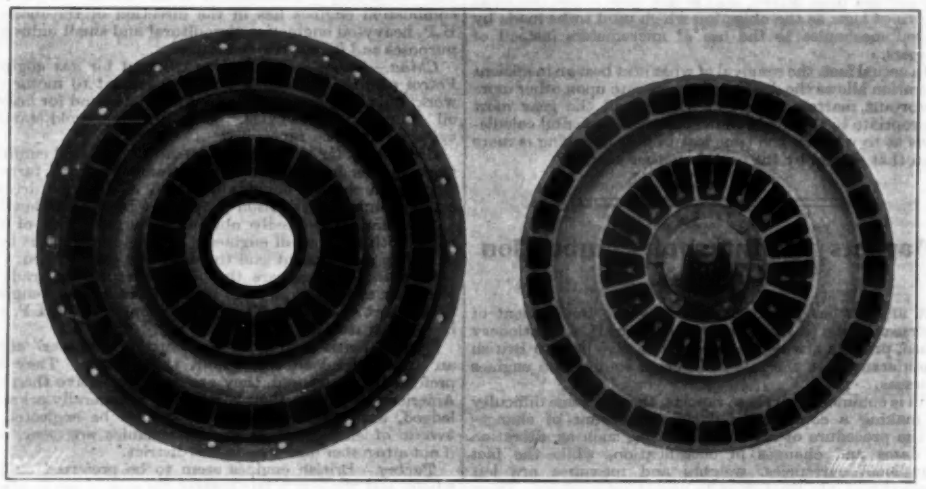


FIG. 1—DRIVING AND DRIVEN MEMBERS OF THE DAIMLER FLUID FLY-WHEEL

When the driving member, which replaces the engine fly-wheel, is in motion, the enclosed fluid is caused to circulate under the influence of centrifugal force. The path of the fluid in the fly-wheel may be regarded as following the stripes on a barber's pole about 4in. diameter, bent into a ring of about 10in. to 12in. mean diameter, the ring rotating like a catherine wheel.

Immediately it flows from the moving segmental cells in the driving member to the stationary ones in the driven member, it impinges upon the radial webs thereof, just as a jet of water from a hose pipe may be made to exert a force at right angles to itself by moving it sideways, and tends to cause the driven member to rotate. Whether it rotates or not depends upon the resistance it offers to the impinging fluid and the force of impingement. As soon as the engine revolves fast enough for the resistance offered by the driven member to be overcome, the vehicle moves off with the utmost docility and sweetness.

The general laws relating to the fluid fly-wheel are as follows:—

(1) The percentage slip for a given diameter and engine speed is proportional to the engine torque.

(2) The torque transmitted for a given percentage slip and engine speed varies as the fifth power of the internal diameter of the driven member.

(3) The torque transmitted for a given percentage slip and diameter varies as the square of the engine speed. The slip percentage is taken on the engine speed.

A driven member of 15in. inside diameter will give 10 per cent. slip at 1000 r.p.m. when 35 H.P. is developed by the engine, so that correlating these figures with the above reveals the fact that enormous horse-power can be transmitted at high speeds without undue slip by light, small-diameter fluid fly-wheels, and that for practical motor car purposes the overall diameter of the fluid fly-wheel, with a permissible degree of slip, happens almost exactly to coincide with that of the standard fly-wheel and clutch.

The fluid fly-wheel rigidly obeys the above laws, except in so far as it departs therefrom due to change of viscosity of the liquid.

The amount of departure is very small, but the lower the viscosity the less the slip.

It may be difficult to realise that a high viscosity is disadvantageous, but such is the case. The desirable fluid is one of low viscosity, and high density, which suggests mercury. If mercury could be used practically, the dimensions of the fly-wheel for any given required characteristics could be reduced to about 60 per cent. of that required for a fluid of less density.

The action of the fluid fly-wheel depends upon the kinetic energy of the fluid, which has practically a true vortex ring action, and not upon any viscous drag.

Fig. 3 shows a characteristic slip curve for a fluid fly-wheel with a stalled torque speed of about 600 r.p.m., the torque being 140 lb.-feet approximately. This means that under 600 r.p.m. the full torque cannot be transmitted. It will, of course, transmit a fraction of full torque at any speed down to zero.

Fig. 3 shows, in addition, the engine characteristic curves plotted against the fluid fly-wheel characteristics, and clearly indicates the high efficiency of the fluid fly-wheel under all level road steady speed conditions, as well as the high efficiency during full throttle acceleration, i.e., 90 per cent. and over at engine speeds over 1500 r.p.m., corresponding to a car speed—with a normal top gear ratio—of, say, 28 m.p.h.

The slip depends, of course, upon the engine torque and the diameter of the fluid fly-wheel driven member. As the torque for a given slip varies as the fifth power of the diameter, it is only a matter of relatively slight alterations in dimensions to put the slip curve just where it may be desired for any given purpose.

It is interesting to note that no torque is lost in the fluid fly-wheel. It gives out precisely the torque which is put into it, neither more nor less. The revolutions of the driven shaft and the horse-power disappear under stalled or idling conditions, but the torque remains. Considering Fig. 3, it will be seen that, whilst the slip is large at low speeds, it rapidly diminishes until at speeds over 1000 r.p.m. the fluid fly-wheel is as efficient as the average road axle.

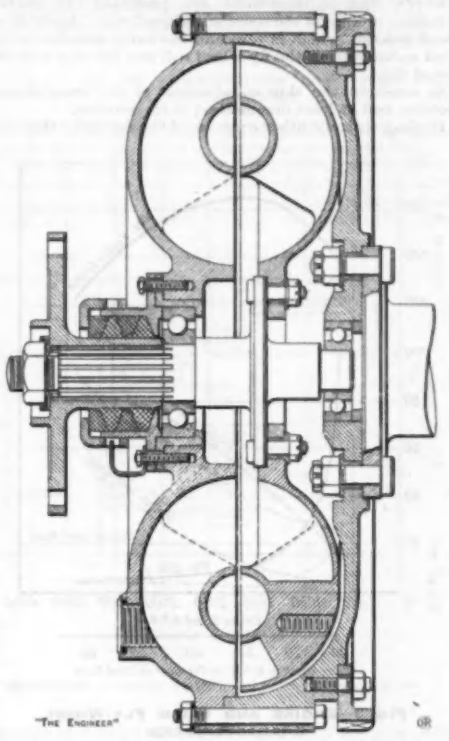


FIG. 2—SECTION THROUGH THE FLUID FLY-WHEEL

Extensive experience shows no measurable difference between the petrol consumption of vehicles fitted with the fluid fly-wheel and that of similar vehicles not so fitted. This is probably because the lower gears are used much less in cars fitted with the fluid fly-wheel transmission.

The action is, of course, quite automatic. It is in a very real sense a torque valve under perfect control by the foot of the driver on the accelerator pedal.

The energy wasted at low speeds or maximum slip is dissipated by the rotating fly-wheel, and is a minor problem in air cooling. If the fluid fly-wheel were fitted to a unit power plant and carried in a fly-wheel bell housing, the problem would be much more difficult, but there is no necessity for this construction, as no clutch pedal or declutching mechanism is used for which a mounting is required.

One interesting mechanical consequence of the large slip at low engine speeds during full-throttle acceleration is that the engine is operating relatively high up on the torque curve, and developing a much higher m.e.p. than if it were connected directly—see Fig. 3. This is quite an important factor in accelerating on top gear from low speeds. Apart from this incidental advantage in respect of torque, the fluid fly-wheel does not profess to be a torque converter.

A further interesting feature arising from the use of the fluid fly-wheel is a complete elimination of over-run effect when the throttle is closed so that the car drives the engine. The reason is that when the torque is reversed, the direction of circulation of the fluid is reversed also, and the slowing down of the circulation in one direction and starting it up in the other is a relatively slow process, ensuring that the reversed forces involved from the rear hub keys through the differential, universal joints, and gears are applied very gently.

It has been mentioned that the fluid fly-wheel is the acme of mechanical simplicity. Referring again to Fig. 2,

* Institution of Automobile Engineers, December 1st, 1931. Abridged.

the driving and driven members are made from heat-treated aluminium castings. No particular accuracy is called for in the segmental cells, and these are quite sufficiently accurate when left as cast.

The problem of balancing was one of the first subtleties that was encountered, for it will be readily seen that the rotating components of the fly-wheel must be in rotary, and, in fact, dynamic balance, including the fluid which is rotating with the driving and driven members.

Each component is therefore filled with wax of the same specific gravity as the fluid used, and balanced with the wax in the segmental cells, the wax being melted out after balancing.

The disposition of fluid pressure in the fly-wheel was quite different from what had been anticipated. Instead of the axis of the fluid fly-wheel being a region of minimum pressure when the fly-wheel was rotating, it was found that considerable pressures existed at this point, so that the design of the gland had to be tackled from the view-point of making it leakproof under all conditions of running instead of regarding it as a device for preventing leakage only when the engine was stopped.

Another of the problems associated with the early development, particularly in relation to omnibus applications, was that during prolonged slipping sufficient heat was generated to expand the fluid sufficiently to generate high pressures in the fly-wheel casing. To avoid this, it is essential that the casing should not be completely filled. The correct amount of fluid is settled by the position of the filling plug.

The nature of the fluid itself has some bearing on this matter of expansion. Thus glycerine, with a coefficient of expansion which is about half that of engine oil, has advantageous characteristics in this respect, as it has also in possessing a higher density and reducing slip in cases where the fluid fly-wheel is used with a larger engine than that for which it was originally designed. On the whole, however, the hydrocarbons are preferable to carbohydrates, if only on the score of reduced cost. Apart from gland leakage, which is rare and instantly manifested by a hot exhaust pipe, the fly-wheel will run for ever without loss of fluid.

So much for the slow-speed aspect of the transmission problem and at least one method of its solution.

Dealing with the other extreme of the necessity that the

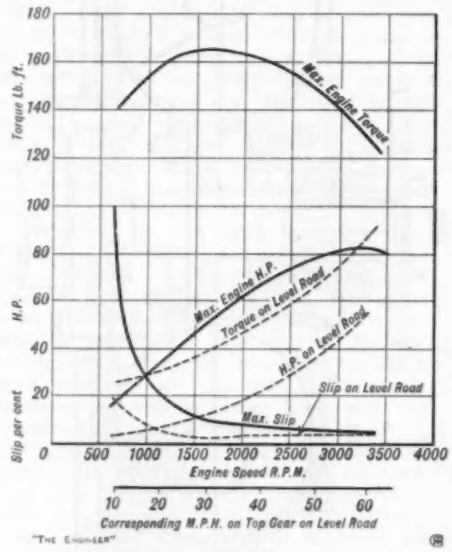


FIG. 3—ENGINE AND FLUID FLY-WHEEL CHARACTERISTICS

transmission system must allow the car to develop its maximum speed, this might be regarded as equivalent to saying that the engine must be allowed to develop its maximum power.

In actual fact cars develop their maximum speed usually when running well over the peak of the horse-power curve. Thus, an engine developing a maximum of 70 B.H.P. at 3000 r.p.m. fitted in a car weighing 2 tons, with 4·4 : 1 gear ratio, is capable of some 75 m.p.h., at which car speed the engine is running at about 3500 r.p.m. Gearing to suit the maximum brake horse-power only results in so diminishing the acceleration that under ordinary road conditions the car rarely, if ever, can be got up to its maximum speed. In this sense the rear axle ratio is regarded as part of the transmission system. It is no uncommon thing to hear talk of the ease of running of a car with a high rear axle ratio, which is tantamount to an admission of indifferent engine design.

The desired variations in torque and car speed are, of course, only partially covered by any geared transmission.

Considerations of silence and efficiency raise at once the question of epicyclic gearing *versus* constant-mesh or sliding gear-boxes. Whilst a high degree of silence is obtained in many constant-mesh gear-boxes, and particularly those with an internal gear reduction, it is the author's view that the epicyclic gear-box scores all round in respect of low tooth pressure, symmetry of loading, and low relative tooth speeds. It is more expensive to construct than the standard sliding gear-box, but as this is rapidly becoming a thing of the past, the difference in cost of manufacture when compared with modern gear-boxes, especially those with free wheels or easy gear-shifting devices, is not so great. It is, moreover, silent on all gears, including the reverse, and by the time other gear-boxes than the epicyclic have fulfilled the conditions laid down by the buying public, there will probably be very little in it from the point of view of cost.

One thing stands out, and that is the very high mechanical efficiency of an epicyclic box, because it can use thin oil and has low tooth pressures. Whilst the pressures per inch of width in constant mesh or sliding gear-boxes can be kept low by increasing the width of the tooth, the tooth speeds are high and thick oil seems to be essential for silence. Thus the mechanical efficiency is seriously affected so that even the use of many steps in the gear-box ratio probably does not compensate for the lowered efficiency in each of them due to the use of thick oil and high tooth speeds.

Foolproofness in operation can be secured by pre-selecting mechanism, either as in the Wilson box or in the Maybach. It can also be obtained by the various types of synchro-mesh mechanisms. These, however, do not quite satisfy the conditions, as it is necessary for the gears to be moving at the correct relative speeds before they can be engaged. Thus, whilst clashing is avoided, definite engagement is not assured unless the spinning member of the clutch is absolutely free.

The epicyclic gear, as such, allows the gear change to be made as rapidly as the brake bands can take up the drive, but, as is well known, one of the defects of the epicyclic gears of the past was the brutally fierce action of the brake bands due to their wrapping action, so that ordinarily their design and adjustment calls for great nicety. Hence the unique advantages arising from the fluid fly-wheel, especially as the inherent fierceness or that due to maladjustment of the brake bands in an epicyclic gear is manifested in inverse ratio to the torque being applied, *i.e.*, it is worse when starting gently on first gear.

The use of the fluid fly-wheel permits the brake bands to be adjusted without regard to obtaining easy action which greatly increases their life and confines the slipping process essential for traffic operation and gear changing to the fluid fly-wheel, where it is rendered perfectly harmless.

Because the car can be brought to rest with the gears engaged and by the use of the simple pre-selection device in the Wilson gear-box, the inexperienced driver can get into a panic on a hair-pin bend, and get out of it by putting on his brakes, getting into first speed, opening his throttle, and starting by releasing the brake.

In mountainous country the engine can be used as a brake with the greatest facility. Lightning gear changes can be made with certainty and ease, even by inexperienced drivers—a very valuable asset in motor omnibus work, where it is often desirable to use tram drivers as omnibus drivers.

The Daimler transmission system has been criticised because it takes away from the skilled driver the joy of a clean gear change. This criticism is never repeated after the car has been driven, and in any case it has the same degree of logic as the objection which used to be made by skilled mechanics to the use of micrometers instead of calipers.

In actual fact, the removal of what is at best an inefficient operation allows the driver to concentrate upon other more important matters. He can use at will the gear most appropriate to the road conditions without mental calculations as to whether the time lost in gear changing is more than that gained by the use of another gear.

Markets for Internal Combustion Engines.

A REPORT has just been issued by the Department of Overseas Trade (it may be obtained from H.M. Stationery Office, price 1s.), which is intended to give help to British manufacturers in the sale of internal combustion engines overseas.

As is common with these reports, there is some difficulty in making a complete analysis on account of changes in the procedure of arranging returns, such as alteration of dates and changes in classification, while the fact that local currencies, weights and measures are left unconverted into English units, complicates affairs. There is, however, one outstanding and easily read lesson in the report. It is that practically throughout the world the suction gas engine is very rapidly waning in popularity, and that the compression-ignition engine is gaining.

The report is concerned principally with small and medium-sized engines, and does not make much reference to the larger units, such as those used on large vessels and at blast-furnace plants; but these can hardly be said to be marketable commodities. The report is divided up into sections according to countries, and below we give some extracts from the various sections.

Australia.—The principal competitor of the United Kingdom in the Australian market for internal combustion engines is the United States of America, in spite of the preference enjoyed by the United Kingdom. The strength of the United Kingdom position and its competitive capacity indicates the efficiency of British engines and their suitability from the points of view of service and price. The imports of gas engines dropped from £48,496 in 1927–28 to £21,674 in the following year, and the losses by the United Kingdom and the U.S.A. were approximately of corresponding proportion, although we did about eight times as much trade as the Americans. In "Diesel" engines there was also a falling off in our exports from £111,094 to £90,320, but there was a more even distribution of the shares of the different countries. Those shares were of the order of 59 per cent. from the United Kingdom, 6·7 per cent. from Germany, nearly 16 per cent. from Switzerland, and 16·5 from the U.S.A. In the case of petrol engines—not those of motor cars—our only serious competitor was America, with about two-thirds of our trade, amounting to £208,561 in 1928–29.

Canada.—Until a few years ago the market for engines for most purposes was dominated to a large extent by engines of United States manufacture, distributed by the Canadian branch of an American firm.

This situation has, however, changed very materially within recent years, since the entry of certain British manufacturers, who, in addition to obtaining the services of capable agents, supported their efforts with the provision of trained *personnel* from the factory, able to advise and afford service on all matters relating to the design, performance and installation of the engine. Only by such methods has it been possible to meet competition. British firms are now obtaining probably 50 per cent. of the business offering in this field, and with an increasing desire on the part of customers in Western Canada to buy British engines there appears to be no reason to doubt that their share of the market will increase.

During recent years a well-known British firm has sold an increasing number of gas engines for working country elevators and appears to have established the fact that its lower initial cost is not offset for some years by the lower cost of the fuel used by the oil engine.

India.—Out of a total of 40,808 tons of internal combustion engines exported from the United Kingdom in 1929 India took nearly 20 per cent., while our share of the imports into India was nearly 75 per cent.

Malaya.—The exports of gas engines from the United Kingdom to the Straits Settlements amounted to £27,538 in 1928 and £16,581 in 1929 respectively, while exports of oil engines were valued at £92,510 and £67,932 respectively. In the case of the Federated Malay States, the exports of oil engines amounted to £34,850 and £29,363 in 1928 and 1929 respectively. They are therefore important markets. It is emphasised in the report that a very simple design of engine is required on this market, rather than one of high economy.

South Africa.—The oil engine is making good headway in the Union of South Africa as a prime mover, and United Kingdom engines are making good progress in that market, as the figures of imports of the Union of South Africa show. The principal competitor of the United Kingdom is again the United States of America, although Sweden in marine engines and Germany in oil and light spirit engines take a good third place in their respective categories. Of marine engines we supply about one-sixth in number, as against two-thirds from America; but the value of our quota was double that coming from the States. In stationary engines the competition seems much more severe, for although we supplied 1828 engines, out of a total of 2852 sets, the value of our share was £89,059, as compared with 231 engines at £14,629 from Germany and 591 engines at £16,896 from the United States.

Portugal.—There is a steady demand for producer gas engines utilising waste materials, which are considered to be the most economical of all types. In this market Great Britain holds the foremost position, with Germany next and Belgium close behind. It is, however, considered that the demand for the producer gas engine will slowly decline, owing to the activities of fuel oil distributing companies, whose aim is to encourage the use of the "semi-Diesel" and "Diesel" engine. At present 60–70 per cent. of the market is in British hands. It is considered that the principal development in the demand for internal combustion engines lies in the direction of the medium H.P. heavy-oil engine for agricultural and small industrial purposes and for electric generators.

China.—There is hardly any demand for gas engines. Petrol engines are almost entirely confined to motor car work, but there is a steadily increasing demand for heavy-oil engines. Two-cycle, solid-injection, cold-starting types seem to be favourites.

Siam.—By far the largest demand for internal combustion engines in Siam to-day is from the small farmer, who is purchasing engines of 1½ to 3 H.P. for driving small pumps for irrigation purposes. In this market the U.S.A. are undoubtedly obtaining the majority of the trade with their small engines. The market for this type of engine is at present said to be heavily overstocked.

Palestine.—It appears that our share of the trade is in the ascendant, that there is no demand for gas engines of any sort and that oil engines of from 7 to 25 H.P. are in greatest demand.

Syria.—British internal combustion engines enjoy an undoubted lead throughout the district. They are preferred, even though they are more expensive than the American article, as their superiority is generally acknowledged, and quality in this line cannot be neglected in favour of cheapness, as good mechanics are very rare if not altogether unknown in this district.

Turkey.—British engines seem to be preferred on the whole, and there is a fair market for sets of up to about 20 H.P.; but Continental firms have secured orders for units as large as 800 H.P.

Algeria.—There is a growing demand for internal combustion engines in Algeria owing to the economic development of the country.

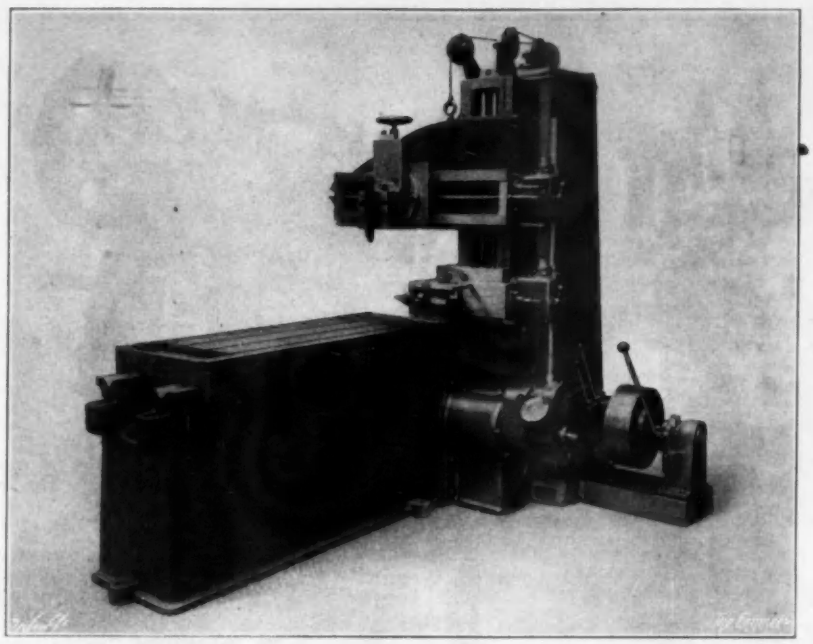
Egypt.—Engines using heavy crude oil are usually above 40 H.P. and form approximately 10 per cent. of the number of engines used in Egypt. These multi-cylinder engines are used for large flour mills, ginning factories, oil plants, power plants, &c. Cold-starter engines using semi-refined oil form about 75 per cent. of the total—a British engine of the horizontal type being the most favoured of this class. The paraffin engine is only used for small powers. About 15 per cent. of the oil engines operating in Egypt belong to this type.

INSTITUTION OF CIVIL ENGINEERS: MANCHESTER ASSOCIATION.

THE eleventh annual dinner of the members of the Manchester and District Association of the Institution of Civil Engineers was held on Wednesday, February 3rd, at the Midland Hotel, Manchester. The chairman of the Association, Mr. E. H. Morris, M. Inst. C.E., presided, and amongst those present were Sir Cyril R. S. Kirkpatrick, President of the Institution, and Messrs. H. A. Reed, S. B. Donkin, and A. Newlands, Members of Council. In accordance with the custom of the Association, the toast of "The Institution of Civil Engineers" was proposed by a student, and the duty fell upon Mr. R. M. H. Garvie, B.Sc., who performed his task with much credit and not without a tinge of humour. Sir Cyril Kirkpatrick, who replied to the toast, said that people who said that the Institution did not move with the times were not aware that the Council could not do everything which it would like to do, and changes in its charter could not be made without the consent of the Privy Council. Critics should remember that the Institution was not a club concerned only with the interests of its members, but a learned and scientific society devoted to the public service. He referred to the recent unsuccessful attempt made by the Inland Revenue authorities to assess the funds of the Institution for income tax, which failed because it was established that the money was accumulated in the public interest. The Council was a very active body, as was evident by the large number of special committees which were

OPEN-SIDED PLANING MACHINE

THE BUTLER MACHINE TOOL CO., LTD., HALIFAX, ENGINEERS



at present sitting. The President made a special appeal to those present to support the Benevolent Fund, on which there is a great drain at the present time. The toast of "The Manchester and District Association" was proposed by Mr. R. A. S. Thwaites, B.Sc., M. Inst. C.E., the chairman of the Yorkshire Association, who advocated the representation of the branches on the Council. Mr. Morris, chairman, who replied to this toast, appealed to the local members of the Institution to support the Association. He said that only 30 per cent. of the members residing in Lancashire and Cheshire were members of the Manchester Association. He would like to see the subscription to this Association reduced. Mr. Morris concluded by tendering thanks to the honorary officials of the Association, particularly the Honorary Secretary, Mr. G. W. Lord, and Mr. H. R. Kiernan, Hon. Treasurer. The toast of "The Guests" was proposed in a humorous speech by Mr. F. W. Bertlin, M. Inst. C.E., and was responded to by Mr. S. B. Donkin, and at the conclusion of the proceedings the student members were invited to meet and have a friendly chat with the secretary, Mr. Jeffcott, and the Members of the Council who were present.

Open-sided Planing Machine.

THE range of crank planing machines made by the Butler Machine Tool Company, Ltd., of Halifax, has recently been extended by the addition of the design which we illustrate above. This machine, of the open-sided type, is intended to combine the ease of operation and quickness of a shaper with the capacity and accuracy of a planer. It is provided with a self-contained gear-box arranged inside the body of the machine. The drive from the line shaft is by single belt to a friction clutch pulley which is equipped with a cone brake which, operated simultaneously with the starting and stopping lever, enables the attendant to stop the table instantly in any position. No countershaft is required, and as a consequence the machine can be placed in any convenient corner of the works where a main shaft is available. Six changes of speed are obtainable, namely, 3, 5, 8¼, 12¼, 21, and 35 cycles per minute. The stroke can be adjusted quickly from 6in. to 48in. and may be set to operate at any part of the table. Both the stroke and its position may be adjusted while the machine is in motion. The feed gear is of the makers' patented self-acting type and may be selected, engaged or stopped while the machine is moving. The stroke movement has a quick return and is so definite that the tool can, it is claimed, be operated without end clearance. The table is supported on vee slides fitted with automatic lubricators and is held down by gibs on both sides. An automatic "one-shot" system of lubrication is fitted to the machine. In addition to the tool-box on the cross slide, a side tool-box is fitted on the upright. This side box has a vertical adjustment of 21in. The machine has a maximum stroke of 48in. Its table is 4ft. in length by 26in. in width. It is capable of planing work up to 2ft. 8in. wide and will admit a height of 2ft. beneath the cross rail.

Mercury Switch On-load Transformer Tap Changing Gear.

OF the many applications of mercury switches one of the most interesting is their use for changing transformer tappings whilst the windings are carrying load. Tap-changing equipments utilising these switches have been introduced by Ferranti, Ltd., of Hollinwood, Lancs., who have given considerable attention to transformer tap-changing problems. The standard mercury switch equipment allows for a maximum of fourteen steps or fifteen running positions, and the scheme has the merit of simplicity. The diagram of connections for one phase is shown on the left of Fig. 1, where it will be seen that eight connections are brought out from the tapped winding to the same number of mercury switches. Alternate switches are connected to the same bus-bar and the two bus-bars are bridged by a reactor with its centre point connected to one of the output terminals. The other output terminal is connected to a point on the tapped winding, the position depending on the number of steps giving positive boost. If this connection is taken to either extreme tapping, the whole range of boost will be of the same sign—positive or negative. If taken to the middle of the tapped windings the range will be divided into equal ± portions. One switch only is closed in the first, third fifth, &c., of the fifteen running positions, whilst in the even numbered positions two adjacent switches are closed, and it will be seen from the diagram that the switches of every adjacent pair of tappings are connected to opposite ends of the reactor, which not only limits the current circulating between the two tappings concerned, but also acts as a 2/1 auto-transformer, so that the voltage applied to the circuit is midway between those two tappings. In the odd numbered positions, *i.e.*, with only one switch closed, the half winding of the reactor which is in circuit produces a small voltage drop, but, as it is at right angles to the load current, it is unimportant unless the power factor of the load is low. The complete step switch as well as the reactor is designed for oil immersion, but access for inspection and maintenance is provided.

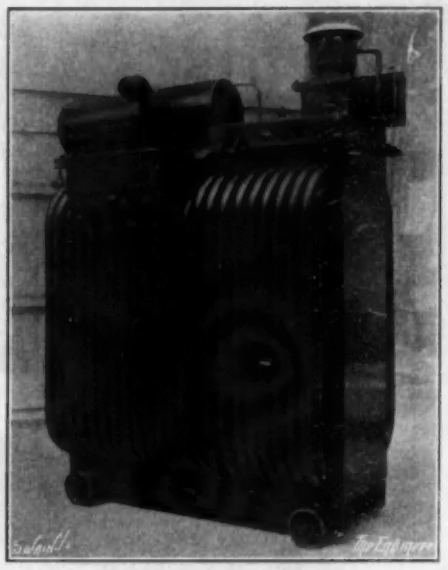


FIG. 3—500-kW TRANSFORMER WITH MERCURY TAP SWITCHES

The switches are inert gas filled mercury units, with a porcelain lining to keep the arc away from the glass, and the length of the joint between electrode and tube is almost equal to the tube diameter, the electrode being taken through the upper wall of the tube and the glass being drawn down on to it. Exhaustive tests are said to have shown that these heavy-duty mercury switches are entirely suitable for use on voltage regulators. The tests included life tests on single switches up to 2,000,000 breaks at full load current and full voltage; short-circuit tests in the closed position and flash-over voltage tests in the open position. Apart from these tests the suitability of mercury switches for the purpose of tap-changing has been proved by the successful operation of a number of equipments in service, including twelve supplied to a South African corporation in 1929.

However slowly the tube may be tilted owing to the surface tension of the mercury, there is a quick make-and-

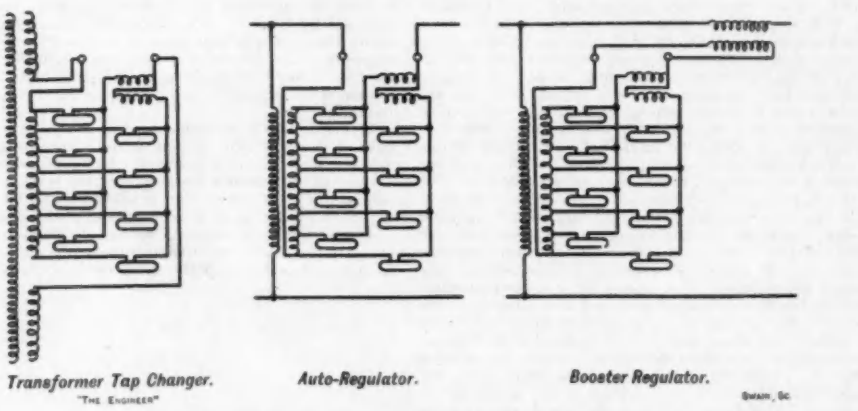


FIG. 1—TRANSFORMER TAP CHANGING CONNECTIONS

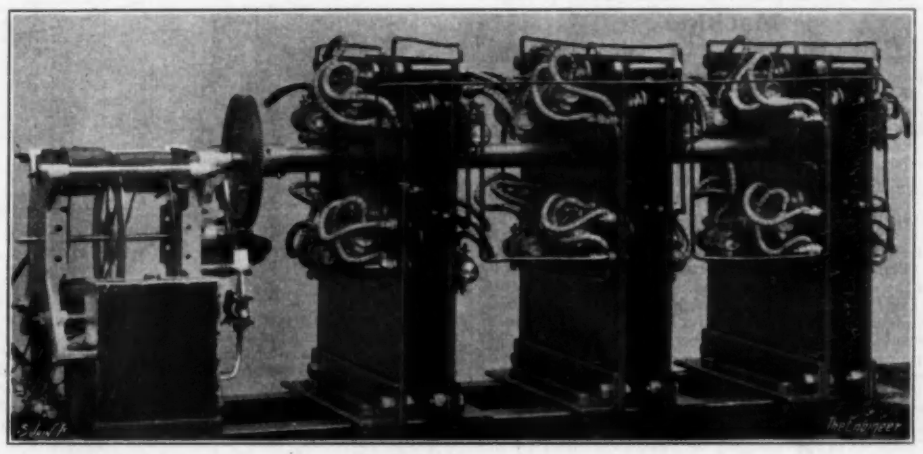
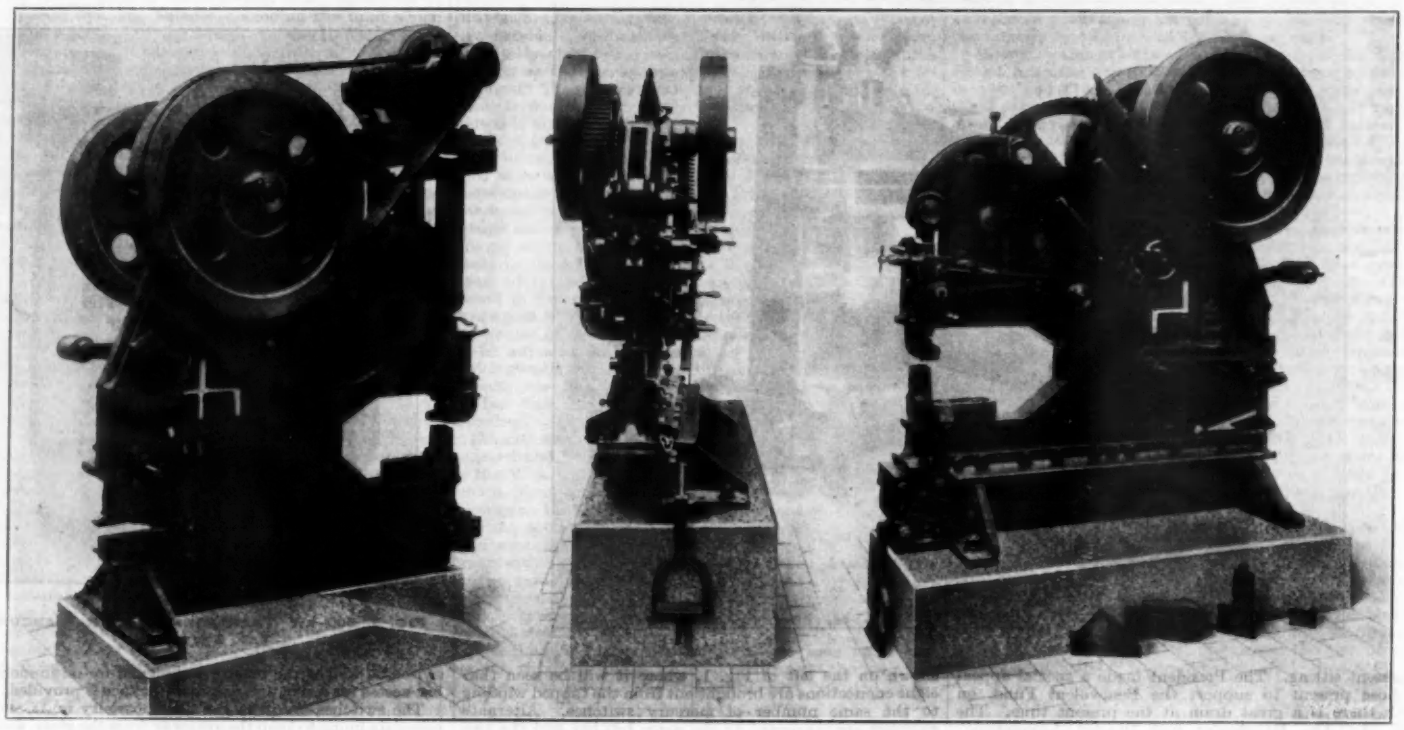


FIG. 2—MERCURY SWITCH MECHANISM

PUNCHING, PLATE-SPLITTING AND CROPPING MACHINE

BERTRAMS, LTD., EDINBURGH, ENGINEERS



break action in these switches, and in the event of the gear stopping in an intermediate position, the partial contact liable to be experienced with other switches cannot occur. No maintenance work has to be carried out on the switch contacts, and as these enclosed switches can be oil-immersed in the main transformer tank, no tapping connections have to be brought out of the tank. As will be seen from the illustration, Fig. 2, the mechanical arrangement is simple. The set of four switches associated with one bus-bar and forming half the switchgear of one phase, are mounted on a stout sheet of Bakelite, and are arranged symmetrically round the operating shaft. The two switch plates of one phase are mounted back-to-back, one on each side of a single Bakelite cam, which operates the eight switches through rocking levers provided with grooved rollers bearing on the cam, and the distance between switch plates of adjacent phases allows easy access to the switches. For automatic or remote electrical operation the Bakelite shaft carrying the cams is driven through worm gearing by a single split-phase induction disc motor, and limit switches are provided to prevent overrunning at the ends of the travel. As all the switches of any one phase are operated by a common cam, any departure from the correct sequence of operations is impossible. The diagram Fig. 1 also shows the application of these switches to an auto-regulator and a booster regulator, whilst Fig. 3 shows a 500 kW, three-phase, 50-period, 11,000/391-volt transformer with fully automatic "on load" mercury tube step switch tap-changing gear, giving a range of plus and minus 6 per cent. of 11,000 volts in nine steps.

A New Punching and Cropping Machine.

IN these days when the tendency is rather to design one machine to do one job, the combined punching, plate splitting, bar, angle and tee cropping machine is one of the few multi-purpose machines that does not seem likely to be superseded. As its long title signifies, it retains the ability to do considerably more than one job. The machine of this type illustrated by engravings and a drawing on this page is constructed by Bertrams, Ltd., of St. Katherine's Works, Edinburgh, and has some interesting features relative to the punch. By the introduction of a new device the makers have so arranged that that tool can be used in five different ways as follows :—

(1) The punch remains stationary at the top of its stroke until the stop motion is engaged. The slide G, of which E is a part, is supported at its high position by the spring and knurled nut B through the lever C and the pin D attached to the slide. When the stop motion is engaged the plunger carries down the slide against the resistance offered by the spring. That spring, however, alone would not be sufficiently strong to return the slide and extract the punch from the hole it has formed in the plate. There is therefore provided a catch H in the slide which engages with a recess in the plunger which can thus withdraw the punch. As shown in the drawing, this catch is held out of engagement by the part A, but for this first method of operating the punch and the two succeeding methods the part A is not attached and the catch is thereby enabled to operate.

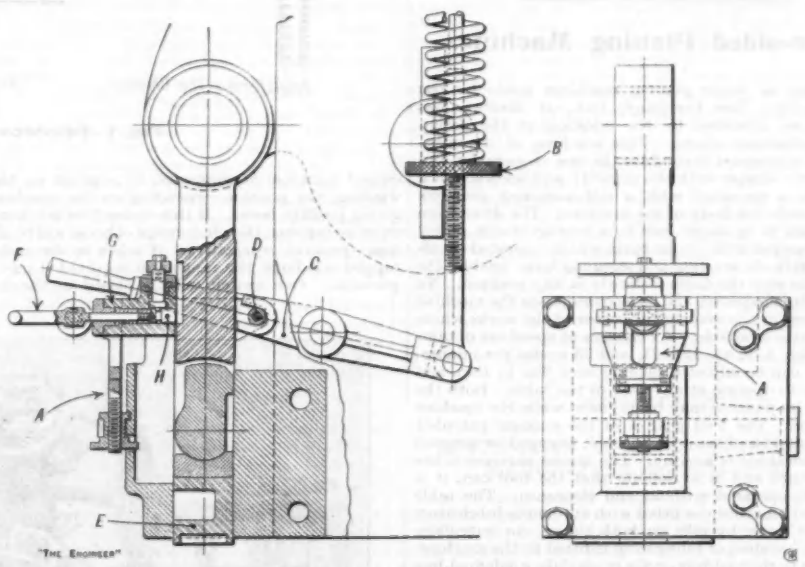
(2) The punch operates continuously. The stop motion of the machine can be operated either by means of a foot treadle or a handle. It will be seen by reference to the engravings that the treadle is attached by a wire to one end of a lever, the other end of which carries a handle, while at the centre there is an arm to which a spring is fixed, being attached at its other end to the frame. For the first method of operating the punch the stop motion was operated by hand or foot. For this second method the spring fixed to the arm of the stop motion lever is detached and replaced on the end of the lever to which the wire from the foot treadle is attached. The stop motion is then permanently engaged and the punch operates continuously.

(3) The punch is arranged to come down on top of the plate at every stroke without actually punching the hole until the stop motion is engaged. All that is required is to slacken off the knurled nut B so that the slide is no longer supported by the spring and is lifted up and let down by the action of the catch H in the recess of the plunger.

(4) The punch is arranged to rest continuously lightly on top of the plate until the stop motion is engaged, when the hole is punched and the slide returns thereafter to its former position. For this operation the part A is slipped into position. This part is made up of an upper forked portion, a screw and a nut to fit the screw. On one side both the arms of the fork are formed into identical cam shapes, while on the other side both surfaces are flat. The specially formed nut on the screw fits into a collar in a casting bolted to the main frame of the machine. The flat faces on the arms of the fork rest against flat surfaces on the same casting, whilst the cam surfaces bear against rollers attached to the rod F, which, it will be seen, is itself attached to the catch H. As shown in the drawing, the cam surfaces hold the catch out of engagement. The operation is now as follows :—The knurled nut B is adjusted until the punch rests lightly on the plate and the nut of part A is adjusted to a previously made mark. When the stop motion is engaged the slide is carried down by the motion of the plunger, but part A remains stationary. Consequently the rollers on the rod F roll down the face of the cams and the catch comes into engagement with the recess in the plunger. Hence on the return stroke the plunger carries the slide with it until the rollers bear once more on the raised portions of the cam so that the catch is drawn out of engagement. Thus the punch can be arranged to rest upon the surface of the job until the stop motion is engaged.

(5) By adjusting the nut on part A the punch can be caused to rise to any desired level above the plate on the return stroke of the plunger, subsequently, when, by the action of the cams, the catch is released, falling to the surface of the plate.

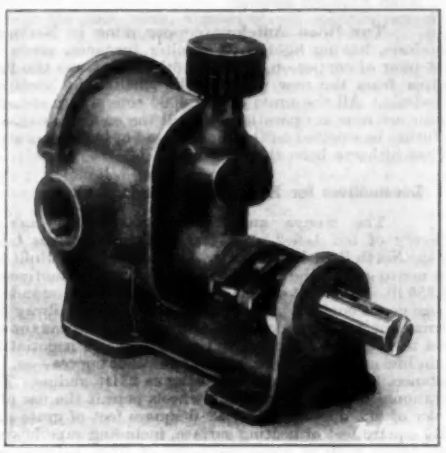
As far as other features are concerned the machine conforms in general with the ordinary well-proved design. The main frame consists of two heavy high-tensile steel armour plates rigidly bolted together by fitted bolts and located by distance pieces, and is so designed that none of the direct stresses are borne by the bolts. Motion is given to the various slides by means of an alloy steel excentric shaft heat treated to give maximum strength. This shaft is driven through spur gearing from the fly-wheel shaft. On the machine illustrated the bar cropper slide is of the lever type and is combined with the splitting shear. It is guided at its outer edge by cast iron guides and bronze adjustable wearing pads. The blades for cropping angles, tees and round and square bars are made up in sections. A downholder is operated by means of a hand wheel conveniently placed above the blades. A graduated adjustable bevelling stop which can be used either at the front or the back of the machine is also fitted. The splitting shear is arranged to shear through plates of unlimited length and width, the groove in the front of the machine being provided with rollers to facilitate the passage of the plate, while the one at the back is made amply wide to ensure that the plate will not jam. The punch is operated from the main excentric shaft through a connecting-rod and steel lever. The machine is made suitable for motor and belt drive, geared motor drive, or belt drive from existing shafting in a wide range of sizes.



DETAILS OF THE PUNCH

A Small Gear Pump.

GEAR pumps are used for a very large variety of purposes nowadays. They have long been used for pumping the lubricating oil in turbines, engines and machine tools, and have also found a use for other duties, such as petrol pumping in garages, or providing the water under pressure for power washing. Being small, handy and simple, they can be used as, so to speak, standby pumps ready to be erected at a moment's notice for any small pumping job. A new design which has recently been brought out by the Parsons Oil Engine Company, Ltd., of Southampton, is illustrated in the engraving herewith. The pump itself is of normal design, comprising two bronze gear wheels carefully designed for silent working, in a bronze casing. It is non-ferrous throughout in order that it may be suitable for fresh or salt water, fuel or lubricating oils, &c. Lubrication is provided by a single screw-down lubricator, communicating by means of drilled passages with all parts requiring grease. The most interesting point in the design is the provision of a substantial outer ball-bearing support for the spindle. This bearing relieves the stress on the gland should the pump be driven by



SMALL GEAR PUMP

belting or gearing. The pump is made in three sizes, ¾in., ⅞in. and 1in. The smallest, running at 1000 r.p.m., delivers 320 gallons per hour and the largest at 600 r.p.m. delivers 980 gallons per hour.

Iron and Steel in India.*

THE iron and steel trade has been only slightly affected by the political movement, but has suffered severely from the curtailment of Government and industrial programmes and also from the restricted purchasing power of consumers of galvanised sheets on account of the slump in jute. After attaining the record figure of 1,197,000 tons in 1927–28, total imports declined to 973,000 tons in 1929–30 and shrank to 622,000 tons last year, the British percentage being reduced to 44, while the shares of Belgium and France advanced to 33·7 and 4·7 per cent. respectively. The most disturbing feature is the phenomenal reduction in the imports of British galvanised sheets from 286,046 tons in 1928–29 to 200,295 tons in 1929–30 and 91,373 tons in 1930–31. This downward trend synchronised with an increase in the Belgian trade from 32,063 tons in 1928–29 to 50,974 tons in 1929–30, which was only reduced to 48,150 tons in 1930–31. Belgian competition in 1930 brought the price down to £11 15s. per ton c.i.f. Calcutta, representing the lowest quotation for thirty years. The Belgians now largely dominate the sheet market in Bombay, but have so far been unable to make great headway in Calcutta. Since the increase last year of the protective duty to Rs. 67 per ton, the competition of the Tata Iron and Steel Company is likely to be much more serious. Their tonnage output in 1930–31 was only 26,450, but considerable extensions are planned. So far, the marketing of British sheets—amounting in 1928–29 to over Rs. 6 crores in value—has been left entirely in the hands of British merchants in London and India, two or three of whom have already placed all their facilities at the disposal of the Belgians and are in fact largely responsible for the development of Belgian competition. The time has come when the leading United Kingdom sheet makers will be obliged to exercise some supervision over their marketing in India, avoiding, if possible, any dislocation of the business of those merchants who are loyal to them. I have, for some time, advocated the formation of a branch of the British Sheetmakers' Association in Calcutta for intelligence, control and propaganda purposes. These activities might be extended by the establishment of central stock depôts at Calcutta and Bombay, from which the merchant distributors might always rely upon being able to draw their requirements of the several brands. Such a departure would enable sheet rollers in the United Kingdom to keep in touch with the developments of the market, would ensure the maintenance of adequate stocks, and would tend to reduce excessive local price fluctuations. This is not the place to discuss the advantages of the establishment by United Kingdom interests of a sheet mill in India, but in view of the magnitude of our interests in this trade and of the serious threat to them caused by the high tariff and Belgian competition, such a development would appear to be inevitable.

United Kingdom rollers of structural sections, plates, and bridgework are on the whole maintaining their share of the trade so far as British standard steel is concerned, but are finding Belgian, German, French, and Luxemburg competition very acute in steel bars and other items for the bazaar trade in which the British standard specification is not insisted upon. The Tata Steel Works are competing keenly in all sections of the trade and are now in a position, not only to supply practically the whole of India's requirements of railway rails and accessories, but also to roll nearly every section required, whether it be to the British standard or not. The recent awards of contracts for the steel work in large bridges, such as Bally and Sagaing, show the severity of the competition with which we are faced. Although United Kingdom bridge builders of world-wide repute are strongly represented in the country, they find it almost impossible to secure the large contracts in view of protective import duties and also—a much more intangible handicap—of the expressed desire of the Government of India to retain as much work as possible in India. A United Kingdom tenderer for an Indian Government contract such as a bridge cannot now count upon receiving the order merely because his is the lowest satisfactory tender, which may even be recommended for acceptance by the engineer in charge of the work. If his competitor is an Indian firm, the Government of India authorities may use the discretion, with which they are now armed, and award the tender to a local firm with the object of assisting Indian industry. Moreover, penalties are rarely, if ever, enforced against Indian contractors for undue delays and other infractions of the contract. In these circumstances, it is not surprising that certain United Kingdom contractors prefer to extend their activities in other parts of the world, where they consider that they receive fairer treatment.

The most satisfactory solution of many of our difficulties in India would be a mutual *rapprochement* between the steel industries of the United Kingdom and of India with the object of preventing overlapping of effort, a mutual arrangement of rolling programmes, delimitation of markets and combination against foreign competition. From such a form of rationalisation on Imperial lines the industries of both countries would receive great advantages, foreign competition would be checked, prices would become more stabilised, and the consumer would be better served.

* From a D.O.T. Report on the Conditions and Prospects of United Kingdom Trade in India, 1930–31, by Thomas M. Ainscough, H.M. Senior Trade Commissioner.

Canadian Engineering News.

Hydro-electric Power Expansion in Nova Scotia.

ACCORDING to a recent statement of the Nova Scotia Power Commission, reviewing hydro-electric power progress, the output in the year ended September 30th last was six times as large as in 1925, or an increase from 25,438,067 kWh to 151,650,000 kWh in the year under review. The growth of the public generation and distribution of power is shown by an increase in turbine capacity over the same period from 22,580 H.P. to a present installation of 62,875 H.P., while the transmission and distribution lines have grown from 94 miles to 266 miles and an additional 55 miles of line is now under construction. The Commission has eight electric power distribution systems in operation and a capital investment of approximately 13,500,000 dollars.

Waterway Negotiations.

Preliminary negotiations have been opened between Canada and the United States with reference to an international agreement for the development of the St. Lawrence River. It appears that the United States is willing to bear the whole cost of construction of works in the International Rapids Section between Prescott and Cornwall, which amounts to between 100,000,000 dollars and 200,000,000 dollars, in consideration of the expenditures incurred by the Canadian Government in sections of the river entirely within Canadian territory, including the 120,000,000 dollars that will be the minimum total cost of the new Welland Ship Canal. This offer on the part of the United States is easily the largest factor in the present situation inasmuch as it serves to remove, so far as Canada is concerned, the spectre of the project's huge cost; but it raises the important question of preservation by the Dominion of its control over its share of the project. Other problems are the preservation of the respective rights of the provinces of Ontario and Quebec, and the securing of the assent of the two provinces to the project as now proposed.

Chignecto Canal.

The Royal Commission appointed by the Canadian Government to investigate the feasibility of a ship canal across the Isthmus of Chignecto, connecting the Bay of Fundy with Northumberland Straits has entered upon its work. For many years the construction of a waterway connecting the bay with the Straits has been urged by many people in the Maritime provinces. The length of the projected canal is about 21 miles, and three different routes, all of them representing about the same mileage, are being considered by the Commission. Arthur Surveyer, of Montreal, is chairman of the Commission.

New Oilfield.

The opening up of an important new oilfield in Southern Alberta is indicated as a possibility by reports from Keho No. 1 well of the Hudson's Bay Oil and Gas Company, which made a new strike of oil, accompanied by a flow of gas estimated at 750,000 cubic feet daily, at a depth of 4925ft., shortly after penetrating the Madison limestone. The new well is situated about 18 miles north-west of Lethbridge. The oil is stated to be of good quality and to be similar to the crude found in the Kevin-Sunburst and Red Coulee fields.

New Bridge Over Fraser River.

Plans have been completed for, and it is intended to start work almost immediately on a bridge across the Fraser River, south of Vancouver, B.C. The estimated cost is 3,000,000 dollars. The bridge, which the Terminal Engineering Company intends to build, will span the main arm of the Fraser, and will provide a new arterial outlet from Vancouver and a direct highway connection to the United States border. The bridge will carry a roadway 30ft. wide, for four lines of traffic, and also a footway. The steel structure will be 1117ft. in length. Over the ship channel the structure will have a lifting bascule, which will give a clean horizontal opening of 300ft. and a vertical clearance of 160ft. above high water.

Pacific Great Eastern Railway.

Extension of the Pacific Great Eastern Railway, owned by the British Columbia Government, from Quesnel to Prince George, has been decided upon. The distance of the proposed extension is 83 miles, and the cost is estimated at 3,000,000 dollars. The provincial Government's railway starts at Squamish, some 40 miles north of Vancouver. The operated mileage to Quesnel is 347, and north of that point parts of the old road bed of the uncompleted line, will be used in carrying the rails through to Prince George. The immediate extension of 83 miles will give the railway an operating mileage of 430.

Mining Plant for Kirkland Lake.

An arrangement has been completed for the construction of a metallurgical plant to recover gold values from tailings resting in Kirkland Lake, Northern Ontario. The accumulated tailings from the gold mines are stated to amount to 4,000,000 tons, and it is intended to construct a plant which would treat 1500 tons of the material daily. The arrangement is between Lake Shore Mines, Ltd., Wright-Gargreaves Mines, Ltd., and Lee Dougan and W. H. Englebright, holders of patents on the milling process.

Oil Burners to be Tested in Canada.

In a very short time Canadian oil burner manufacturers will be able to have their burners tested in governmental laboratories at Ottawa instead of in the Fire Underwriters' Association laboratories at Chicago, U.S.A. With the coming opening of the National Research Council laboratories, Canadian burners will go directly to Ottawa for testing and will receive a Canadian standard. The Bureau of Standards of the National Research Council will do all the testing work.

Coking Plant for Head of Lakes.

Under the terms of an agreement recently entered into with the lakehead cities of Fort William and Port Arthur, Mr. A. T. Leavitt, vice-president and general manager of the Hamilton By-product Coke Ovens, Ltd., and his associates are to erect and have in operation within one year a coke plant and gas distribution system costing not less than 500,000 dollars and with a capacity of not less than 1,000,000 cubic feet of gas per day. It is indicated that the expenditure is likely to reach 2,000,000 dollars in time. It has not been decided in which city the plant will be located.

Sodium Sulphate.

A new mineral industry, reported to be the fifth of its kind in the province of Saskatchewan, is being opened up at Whiteshore Lake, some 62 miles west of Saskatoon, where one of the largest sodium sulphate deposits in the province is to be exploited. The deposit in the bed of Whiteshore Lake is estimated at nearly 20,000,000 tons and the present plans for development are those of the Whiteshore Lake Salts and Chemical Company. The company is erecting a plant which is expected to be in operation before the end of 1931. The salts taken from the lake bed will be subjected to an evaporating or drying process to produce anhydrous salts for shipment. The bed of Whiteshore Lake covers a total area of some 1800 acres.

Machinery.

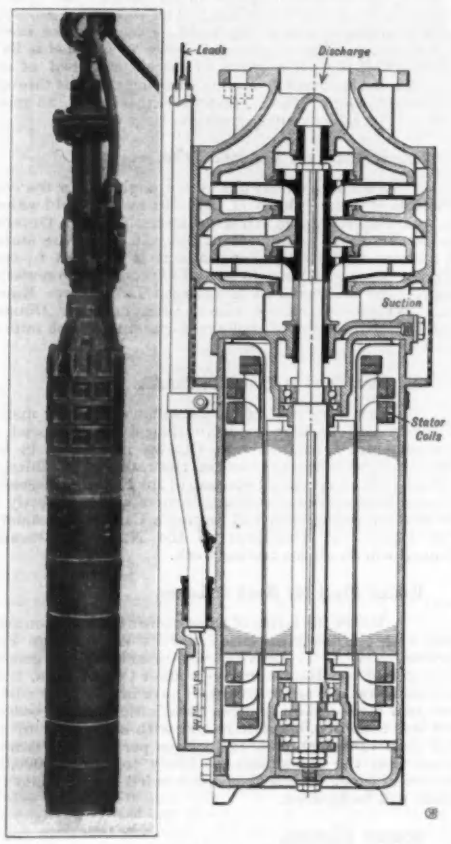
Some indication of how Imperial preferences and higher Canadian tariffs are affecting machinery imports from the United States is given in a recent Government review. Imports of machinery from Great Britain in the two years ending September, 1931, had a value of 3,700,000 dollars in each of the two years, whereas imports of machinery from the United States fell from 53,000,000 dollars in 1930 to 29,000,000 dollars in 1931. Under this general heading, however, it is noteworthy that Canada's imports of textile machinery from Great Britain increased from 528,000 dollars to 910,000 dollars at a time when imports of this item from the United States fell off from 4,300,000 dollars to 3,084,000 dollars. In most items where there has been a change in ratio it is like that shown for mining machinery, where the total imports from Great Britain fell off from 550,000 dollars to 464,000 dollars, as against a fall in imports from the United States of 8,000,000 dollars to 3,100,000 dollars. The value of rolling mill products imported from Great Britain fell off by one-seventh, while the value of rolling mill products imported from the United States decreased by one-third.

New Process in Lignite Field.

The first full-scale test of the new Morfit process for the manufacture of briquettes from the lignite coal of the Estevan-Bienfait fields, Southern Saskatchewan, was carried out recently at the plant of the Western Dominion Collieries, Taylorton. The new process, which was evolved at the plant, after elaborate experiments by C. C. Morfit, a member of the New York engineering firm of Stuart, James and Cooke, is stated to be of a revolutionary nature, and is likely to have a wide influence on the industry. In the new process the lignite coke after coming from the carbonisers is mixed with the asphalt binder in the usual way, but in the new system an improvement to the Lurgi retorts has been devised, whereby in the third and final stage of carbonisation a new method of cooling the coke is introduced. This latter process, it is stated, makes it possible to store the product, either in coke or briquette form, without danger of disintegration, crumbling or spontaneous combustion.

Bore-hole Pumping Plant.

NEARLY every one of the large new office buildings erected in London, it would seem, is equipped with its own water supply arrangements, while many of the older buildings and certain factories in the area are also desirous of having a supply independent of that provided by the Metropolitan Water Board. The water is obtained in nearly every case by pumping from a bore-hole. Three forms of pumping equipment are in use :—The reciprocating plunger type, the centrifugal pump dropped down the well, and the air lift. Whilst the last-named is only suitable for certain applications and suffers from a low



FIGS. 1 AND 2—SUBMERSIBLE MOTOR-DRIVEN PUMP

efficiency, the greatest disadvantages of the centrifugal pump arrangement are the length of vertical shafting and the labour of lifting the pump to the surface for overhaul, or in case of damage. With either the centrifugal or reciprocating type, it is absolutely necessary that the bore-hole shall be straight, any deviation being certain to cause trouble sooner or later, while the lubrication of the various bearings, especially when the well water is sandy or gritty, presents a difficult problem.

An interesting centrifugal pump designed to get over the many difficulties has been put down by C. Isler and Co., Ltd., of Bear-lane, Southwark-street, London, at Thames House, Millbank. The engraving, Fig. 1, and the drawing, Fig. 2, illustrate it. In order to avoid the necessity for a long shaft down the well, the motor is made submersible and placed directly below the pump itself. Water is allowed—is in fact, deliberately placed—within the A.C. motor. The stator coils, however, are enclosed in a welded container absolutely air and watertight, but water has access to every other part and acts as the cooling medium. Plugs are provided at the top and bottom of the casing for filling purposes. The pump itself, carried above the motor, is of normal multi-stage design, the number of stages being three at Thames House, with a fourth dummy stage incorporated in case the necessity should arise for further raising the delivery head. The cables to the motor are carried down the well in a specially constructed hose pipe, impervious to water, and the junction box on the side of the motor is, of course, also sealed against leakage. It will be seen that besides the delivery pipe the only other thing passed down the well is the cable to the motor. Thus, even though the bore-hole should not be straight or vertical, so long as the pump and the piping can be successfully lowered, the result will be satisfactory. At Thames House the diameter of the bore-hole is 12in. The pump running at 2850 r.p.m. delivers 9800 gallons per hour against an underground lift of 173ft. and an additional lift above

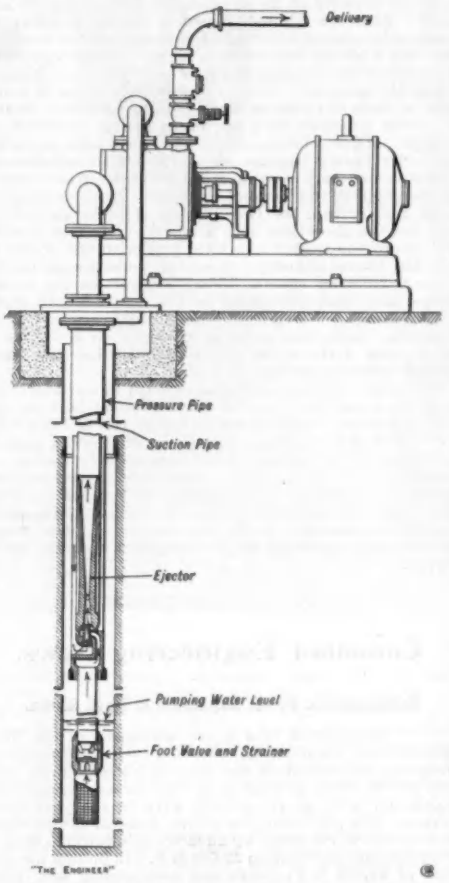


FIG. 3—EJECTOR SUCTION PUMP LAY-OUT

ground of 20ft. The motor runs on 3-phase, 50-cycle current delivered at 400 volts, and develops 25 H.P., the efficiency of the pump being 44 per cent.

At present the motor and pump unit is of foreign make, but C. Isler and Co., Ltd., state that it is hoped in the near future to construct the unit in this country.

Another arrangement recently developed by the firm utilises the ejector principle to bring the water from a greater depth to within the suction powers of the pump itself, which is placed at ground level and is thus open to inspection. The only apparatus within the bore-hole is a double pipe and the ejector cones. A pumping unit of this type is illustrated in the drawing, Fig. 3, and the engraving, Fig. 4, shows an electrically driven pump. Water is taken under pressure from the first or second stage of the multi-stage pump and delivered down the well in the annular space between the main suction pipe and the pressure pipe. Near the bottom of the hole it passes upwards again through a nozzle and into a combining tube, entraining with it water from the bore-hole. This water then passes upwards to the suction of the pump itself, and is delivered by it to storage tanks, or any other convenient place. An ejector suction pump, working on this principle, is being installed at the Palladium Theatre in London, to give a delivery of 1000 gallons per hour with a lift from below of 360ft. and a delivery head above the pump of 70ft. The pump has four stages and is driven at 2900 r.p.m. by a 14 H.P. D.C. motor. The bore-hole is 7½in. in diameter and 400ft. deep, penetrating to the chalk.

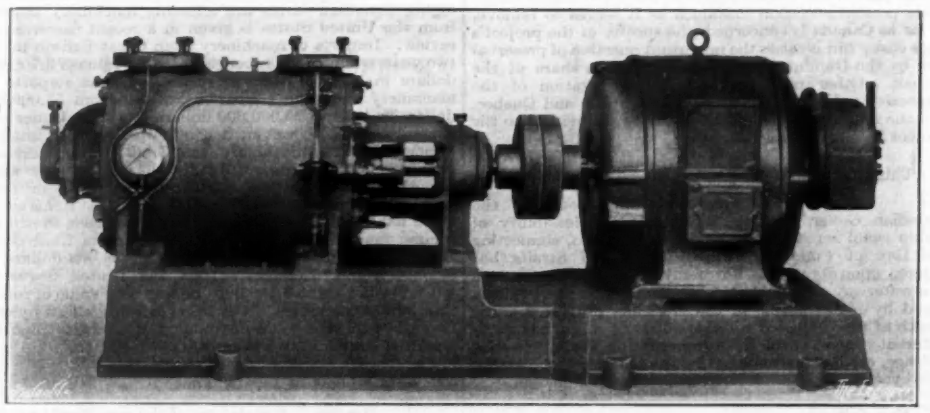


FIG. 4—CENTRIFUGAL PUMP FOR EJECTOR SUCTION PUMPING ARRANGEMENT

A similar unit having a three-stage pump running at 1440 r.p.m., belt-driven from a steam engine, delivers 4500 gallons per hour against a suction head from below of 120ft. and a delivery head of 24ft. above at the expenditure of 9·75 H.P. with an overall efficiency of 35 per cent. This unit is installed at a Croydon laundry, and is, we understand, giving complete satisfaction. The bore-hole is 6in. in diameter by 307ft. deep. Compared with the more normal arrangement, in which the pump is some hundreds of feet below ground and the driving motor or engine on ground level, the new lay-out appears to have considerable advantages. There can be little doubt of the advantage of a lay-out which allows all the moving parts to be kept at ground level and open to inspection. The equipment can be duplicated to give a standby unit, where the installation consists of only one bore-hole. In the majority of cases the higher the lift is above surface the greater the efficiency.

South African Engineering Notes.

Roan Antelope Smelter.

THE Roan Antelope copper mine in Northern Rhodesia, having lighted its smelter furnaces, made its first pour of copper on October 16th. That was the first copper from the new mines to be smelted in Northern Rhodesia. All the units of the 6000 tons a day concentrator are now in operation, and all the concentrates will in future be smelted on the spot instead of being exported, as has hitherto been the practice.

Locomotives for Kenya and Uganda Railway.

The Kenya and Uganda Railway is taking delivery of ten 4–8–2+2–8–4 Garratt locomotives built by the North British Locomotive Company, Ltd. Built for the metre gauge, the tractive force of these locomotives—40,255 lb.—is almost double that of the ordinary standard gauge goods engines. They are designed for a railway the permanent way standards of which limit the maximum load to 10½ tons per axle, and are capable of negotiating main line curves of 410ft. radius and other curves—as, for instance, those in sidings—as sharp as 231ft. radius. The additional bogies and carrying wheels permit the use of a boiler of 6ft. diameter with 43·6 square feet of grate and 2417 square feet of heating surface, including superheater, also tanks with a water capacity of 5250 gallons and 6 tons oil capacity. The fire-box is equipped for oil burning, but provision is made for conversion to coal burning if required. The cylinders—four—have a diameter of 16½in. and a stroke of 22in.; the boiler working pressure is 170 lb. per square inch, the tractive effort at 85 per cent. of the boiler pressure 40,255 lb., and the weight in working order, with tanks full, 137 tons 2 cwt. The locomotives are fitted with the Westinghouse brake acting on all coupled wheels. The boiler contains a thirty-two element superheater.

Rail Durability.

Some little time back the Union Railway Administration decided to relay the railway line between Mafeking and Bulawayo on account of the heavier engines and larger train loads operating over that section. During the course of lifting the old rails and sleepers some very interesting facts were brought to light which demonstrated the lasting qualities of British material put in place very many years ago. The 45 lb. rails taken out of the track bore date as far back as 1868–1875. These rails had evidently formed part of the old 4ft. 8½in. gauge line laid down from Cape Town to Wellington, and when the gauge of that section was converted to 3ft. 6in., the rails were transferred to other lines, being used, later, on the line from Vryburg to Mafeking, about the year 1894. As the volume of traffic to be hauled over the line increased, the latter section was relaid with 60 lb. material, and these old rails were then used in loops and sidings on the Mafeking–Bulawayo line, and finally taken out in 1930. Most of the rails are still in an excellent state of preservation, and those that are serviceable are again being used on the Matopos branch, where the train loads are much lighter than on the main line. The history of the steel sleepers is also of interest, a number of them being dated 1895-1896. They were spaced 1936 to the mile, and were packed chiefly with sand. These sleepers have stood the stresses of the increasing weights and speeds of trains for thirty-six years, and a number can still be made use of where the traffic is lighter.

Rhodesian Railways.

The *Railway Bulletin* of the Rhodesia Railways for September records decreases under most of the principal traffic heads. Relatively small drops are registered in respect of coal and coke from the Wankie Colliery, and of chrome ore railed from Southern Rhodesia, while asbestos railings were about the same as in September. The biggest fall was in copper exported from the Congo to Beira, the figure for September being 2439 tons, as compared with 4088 tons for August. The railings of copper concentrates from Northern Rhodesia fell from 5802 tons to 5379 tons. Figures covering the ten months ended July last show a decrease on the preceding ten months period in the total earnings in South Africa from £4,384,705 to £3,505,936, and in the total gross operating expenditure from £2,928,744 to £2,583,086, there being thus a fall in the net operating revenue for the ten months of over £500,000.

Rail Rates on Coal Reduced.

While the Union Railway Administration is raising passenger and luggage rates and is imposing a temporary surcharge of 1d. per 100 lb. on certain classes of goods traffic and coal for local consumption is also to be subjected to a special temporary surcharge for short distances, it is reducing the rates on wool by 33⅓ per cent. and by 5s. per 2000 lb. on bunker coal to Lourenço Marques. During the financial year ended March 31st, 1931, the coal

bunkered at those two ports fell 25 per cent., as compared with the previous twelve months, and a still further falling away was recorded during the past six months. The reductions in the railway rates are subject to the free alongside ship price being fixed by the coal trade at 18s. 8d. per ton of 2240 lb. at Durban. It is doubtful, however, whether the reductions in railway rates and in the price for coal at port will suffice to enable the Natal and Transvaal Collieries to compete with the low prices at which coal is obtainable in Great Britain and which is inducing steamers to carry sufficient coal for the outward and homeward trips.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

General Situation.

THERE has been little alteration in the general industrial situation in the Midlands and Staffordshire during the past week, and while the outlook has been improved by the change in the fiscal policy of the country, it is recognised that some time must elapse before any material advantage can accrue therefrom. Even in departments in which British-made iron and steel may possibly take the place of foreign material there is no increase in activity as yet. The stocks of imported material accumulated in the Midlands and Staffordshire will last for some months. The iron and steel trade, however, generally feels that the present duty is not high enough to check imports, but it is hoping for increased assistance in its fight against the foreigner from the Tariff Commission. In industrial circles here it is believed that a big step towards industrial recovery has been taken, and, consequently, hopes of the future have increased. Some of the lighter trades in this area have been helped by the anti-dumping legislation and the benefits to be derived will be increasingly felt as time passes. At date, practically all branches of engineering are quiet, particularly the constructional industry. It is feared that the call of economy will hit this trade very badly. Little business was transacted on 'Change in Birmingham this week, though some producers reported a slight improvement in specifications against existing contracts.

Iron and Steel Tariff.

It is very evident from the speeches at the sixty-sixth annual dinner of the Staffordshire Iron and Steel Institute, at Dudley on Saturday last, that the Government's present tariff proposals have given but partial satisfaction to sections of the heavy industries in this area. Mr. Alexander Ramsay, M.P. for West Bromwich, chairman of the Engineering and Allied Employers' Association, in proposing the toast of "The Iron and Steel Trades," declared that a 10 per cent. tariff was not nearly enough, even taking into account the depreciated pound. Indeed, as regarded many products, of which iron and steel was one, 10 per cent. would be a positive disadvantage to the community. One had to assume from prices which foreigners had been quoting recently, that they had nearly got to rock bottom. If the 10 per cent. went on to imports of that kind, it was a fair assumption that foreign prices would go up, and if they did not go up enough to keep the stuff out, the English consumers were going to be the people to pay. He looked to the Tariffs Advisory Board to give the trade an effective degree of Protection. Sir Harris T. Spencer, a Vice-president of the Federation of British Industries, who replied, said that, in his opinion, the principle which should be at the basis of the whole treatment of the industries of the country was that everything that could be manufactured here must be manufactured here. Dealing with the consumers' objection to that principle on the ground of price, he declared that the extra productivity would bring down charges to such an extent that goods would be cheaper than they were to-day.

Manufacturers' View.

The Midland Council of the National Union of Manufacturers on Monday passed a resolution cordially welcoming the Government's tariff policy and stating that it recognised that it was a foundation upon which an effective and useful tariff structure could be built. It pointed out that the Midland Council, since its formation in 1916, had never wavered in its advocacy of a tariff upon imported manufactured goods, and it further pledged the Council to render every possible assistance in carrying the new policy to a successful issue.

Hydraulic Power.

I am given to understand that Birmingham's only hydraulic power station, which was established in 1890 for the supply of water at high pressure for the working of lifts and other apparatus, is to close. With the development of electric power, the need for it has declined. Moreover, for many years, with few exceptions, a loss has occurred on working owing to the declining number of consumers. It is felt that the station has now outlived its usefulness.

Pig Iron.

Demand for Midland brands of pig iron continues to decline, and producers are very anxious for specifications against contracts. There are, as yet, little prospects of iron being required on any large scale by the engineering foundries in this district, and the slackness in the building industry has further reduced the demand from the light castings trade. Derbyshire and Northamptonshire blast-furnacemen have some good orders on their books for supplies to the end of the quarter, and in some cases even longer, but users are backward in giving delivery dates. Production is maintained at about recent levels, but some of the output is going into stock. As there is little likelihood of any change in selling prices of pig iron this month, consumers who buy on the open market are only taking sufficient material at a time to cover immediate requirements. Tonnages are very small. Blast-furnace coke prices are still comparatively reasonable for the season of the year. As large supplies were bought by furnacemen when prices were unusually low last autumn, few have to pay even to-day's rate for their fuel. Pig iron prices show no change on the week. Derbyshire No. 3 foundry is £3 6s., Northamptonshire at £3 2s. 6d., with forge grades 5s. per ton less in each case.

Finished Iron.

Though there has been a slight improvement during the week in demand for best quality finished iron the general position of the industry is unchanged, and there is little prospect of any real expansion of business in the near future. Staffordshire ironmasters view with concern the heavy stocks of Continental material which have accumulated in the works and on sidings in the Black Country. The 10 per cent. tariff which is to be imposed next month will affect local ironmasters hardly at all. The disparity between native and Belgian prices is considerable. Staffordshire mills are only operating a few days each week, activity being greatest in the marked bar and in the tube strip branches. Best grade bars continue to sell at £12 per ton at makers' works. Crown bars are obtainable in Birmingham at £9 5s., but there are few Staffordshire makers, if any, who would accept that figure. They ask about £9 15s. and upwards. Nut and bolt and fencing bars are in very poor request and the quotation of £8 7s. 6d. is considered by users to be merely nominal. Wrought iron tube strip is quoted £10 10s. to £10 12s. 6d., but it is said that the bulk of the business passing is accepted at the lower rate. Strip mills are just a little better placed than they were a week or so ago.

Steel.

In the steel industry in this area business continues poor. Rollers of heavy material such as joists, sections and plates are the worst off, but re-rollers are also finding it increasingly difficult to keep plant in operation. Midland structural engineers see no improvement in the outlook and their orders, in almost every case, are for small tonnages of material. Steelmasters are hoping for further State protection, though it is in the semi-finished branches rather than in the finished section that Continental competition is most felt. There is no change in prices of finished steel. In the half-products branch the market is feeling its way. In the main branches of consumption, manufacturers have covered their requirements for the present, whether they use British or foreign raw material. They now seem disposed to circulate inquiries as to prices but not to place business. Local re-rollers still quote £6 12s. 6d. upwards for small re-rolled bars, and £7 5s. upwards for all British. Soft billets are quoting £5 7s. 6d., sheet bars £5 5s., and Staffordshire hoops £9 10s. per ton delivered.

Galvanised Sheets.

There is a moderate demand for galvanised sheets and makers are just about able to maintain selling prices at last week's figure of £9 5s. to £9 7s. 6d. A few mills still quote 24-gauge corrugateds at £9 10s., but this appears to be above the market level. The call for black sheets is below normal for the period of the year, the automobile industry being unevenly employed.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Engineers and the Tariff.

INQUIRY among iron and steel and engineering trade interests on the Manchester Royal Exchange this week more or less substantiates the official statement issued last week-end by the British Engineers' Association in which, whilst the change in the country's fiscal policy was welcomed, the opinion was expressed that a 10 per cent. tariff offered the industry little or no protection. Among Lancashire engineers, the view is quite definite that far more than 10 per cent. in the majority of instances is needed to bridge the gap between British prices and those at which Continental and United States firms are offering competitive products in the home markets. Similar opinions are held concerning the steel trade, including both the heavy materials and the special alloy steels, and the finished iron trade. In respect of foundry iron, so far as the Lancashire district is concerned the position is rather different. It is a year or two now since Midland ironmasters who serve the major needs of this area had occasion to complain of competition from foreign pig iron, although, of course, sales of Scottish brands to Lancashire users have been adversely affected for some time by the much cheaper offers of Indian iron, which, according to the Government plans, will not be subject to the duty. The 10 per cent. tariff, therefore, does not directly concern ironmasters who are selling in this district. On the other hand, they see in it possible benefits to those iron consumers whose foundries are concerned with both light and heavy iron castings, and also with steel castings, with, of course, ultimate benefit to foundry iron makers themselves.

Electricity versus Gas.

Manchester Corporation Electricity Committee has recently been concerned by a statement in the "economy" report of the Expenditure (Special) Committee of the City Council regarding the cost of converting the system of lighting in certain schools from gas to electricity. The Chairman of the Electricity Committee—Alderman Walker—in bringing the matter to the notice of the City Council at its last meeting, urged that, if the statements in the "economy" report were taken from their context, they might be used to suggest that, in the opinion of the Expenditure Committee, gas was a cheaper illuminant than electricity. A proposal by Alderman Walker that the statements in question should be referred by the City Council to the Expenditure Committee was, however, defeated by a narrow margin of votes.

The Liverpool–East Lancashire Road.

At the meeting of the Lancashire County Council last week the Highways and Bridges Committee reported that the contractors continued to make very good progress with the work of constructing the new road from Liverpool to East Lancashire, and that two-thirds of the concrete foundation for the road had been completed. The Committee, however, in conjunction with the officials of the Ministry of Transport, has agreed to the work of surfacing the road being postponed for a limited period, a condition being that, when the work is carried out the Treasury grant of 75 per cent. will not be varied. This postponement will necessitate treating the concrete slab with a bituminous coating and granite chippings, the cost of which is estimated at £10,000. By that means, it was stated, the expenditure of about £250,000 would be saved for the time being. It is expected that, before long, three sections of the new road, altogether about 9¼ miles in length, will be thrown open for traffic.

Non-ferrous Metals.

A relatively poor trade demand for most classes of metals has been a continued feature of the non-ferrous metals market during the past week, and whilst lead has been about maintained at the lower levels quoted a week ago, there has been a further loss of ground in other sections. The latest statistics relating to tin show a reduction in the visible supply of the metals, but heavy stocks are held in the producing countries, and altogether, therefore, the statistical outlook is not regarded by the market in too favourable a light. The turnover was only very moderate in the aggregate, with consumers of the metal playing a minor *rôle*. Selling pressure from speculative interests has also been a "bearish" factor. Under the circumstances, the loss of about £2 10s. per ton on balance for the week is not surprising. The demand for copper from almost all directions remains poor. Equilibrium between world supply and demand is a problem that seems to be no nearer a practical solution than it was a year ago, and in consequence a lack of stability about the market is the dominant feature. The loss of between £1 10s. and £2 per ton in standard brands since last report has brought current values lower than they have been since about the end of November. The poor buying interest in lead has been more or less neutralised by the fact that offers of the metal seem to be fairly well controlled, and quotations in this section have been about maintained. Quiet business has also been experienced in the case of spelter, with a consequent decline on the week of rather more than 5s. a ton.

Iron and Steel.

Pig iron sellers in this district have little to complain about regarding the volume of deliveries being taken by users, but they are certainly disturbed by the continued absence of any indication of reviving interest in new forward buying. The lull has lasted from early in December, and there is disappointment that improvement in that respect has not been registered before now. Fresh sales during the past week have been appreciably below normal, with the quietness especially pronounced in Scottish brands. Prices are steady, however, at 67s. per ton, delivered to users in the Manchester price zone, for Derbyshire, Staffordshire, and North-East Coast makes of No. 3, 65s. 6d. for Northamptonshire brands, about 87s. for Scottish, and 81s. for West Coast hematite. Trade in manufactured iron is described as very unsatisfactory indeed, and fairly heavy stocks of foreign material are believed to be held by consumers. Lancashire Crown quality bars are maintained at £9 15s. per ton and No. 2 grade at about £8 5s. The demand for all classes of steel during the week has been restricted, and no more than small miscellaneous sales have been effected, with sales of special alloy steels also only on moderate lines. Quotations are steady generally, with no changes compared with last week to record. Except that there has been marked anxiety to hasten deliveries of foreign materials on order, there has been no anxiety to buy in the market for Continental iron and steel products.

BARROW-IN-FURNESS.

Hematite.

The hematite pig iron market is quiet on the whole, and, owing to the fluctuating demand for steel on local account, the whole of the output is not being cleared. There is still no tendency on the part of buyers to place orders ahead, and business is, therefore, mostly confined to supplying consumers with just sufficient to keep them going. There is still plenty of iron in stock in the district. It is far too early to anticipate the effect of the 10 per cent. tariff, and it may be months before the actual results are known. But for the fact that both Continental and American buyers are needing but little iron at present, there would be heavy shipments from West Coast ports, for hematite pig iron at prices reduced by the value of the pound should prove a great temptation to buyers. The iron ore trade is naturally very dull at present, and is likely to remain so until there is an increase of iron output. The steel market is very quiet, and the Barrow rail departments are idle again this week. The labour troubles in Cumberland have been settled, and the Workington rail mills are engaged again after a few weeks' stoppage. The hoop and small section mills at Barrow are fairly well circumstanced.

SHEFFIELD.

(From our own Correspondent.)

Sheffield and the Tariff Bill.

THE Sheffield steel trade is still waiting for something that will help it to compete with the foreigner and to regain a position of prosperity. The Government's Tariff Bill does little in that direction. Steel imports will be subject to the general revenue duty of 10 per cent.,

but that is quite insufficient to give the trade protection against foreign rivals. While leaders of the trade in Sheffield regard it as a step in the right direction, they are strongly hoping that it will be followed, when the Tariff Committee gets to work, by something much more substantial. A tariff of 33⅓ per cent. has been suggested for alloy steels, crucible steels, forgings and castings. Sir Arthur Balfour, in an important speech last week, said that he had come to the conclusion that we must protect iron and steel. We could not allow this country to fall as a producer of iron and steel—which came as near being key industries as anything we could touch—to the point at which our imports were as great as, or even greater than, our actual manufactures. An independent body, known as the Sheffield Industries Imports Committee, has been set up to watch legislation regarding restriction of imports affecting Sheffield trades. The chairman is Mr. R. W. Matthews, one of Sheffield's representatives on the Tariffs Committee of the Association of British Chambers of Commerce.

State of the Heavy Trades.

The present position of the trade in open-hearth steel and heavy forgings not only shows no improvement, but is worse than at any time since the holiday stoppage. Considerable numbers of men who were suspended at Christmas are still unemployed. The United Steel Companies is comparatively well situated, as it has managed to maintain its output on the pre-holiday scale. It has seven large furnaces in operation at Templeborough and two at Rotherham, and production per furnace at those works has been increased in recent years. Steel producers generally, however, are finding increasing difficulty in disposing of their output. Business for bulk quantities is very scarce, and for the most part consumers will not order more material than is necessary to cover current requirements. The stainless steel department, which has enjoyed improved activity for some time, has recently shown a falling off, but the production is still on a large scale.

The Lighter Side.

The story with regard to lighter steel products is a better one. The trade in cold-rolled steel and strip is benefiting from the increase in foreign prices brought about by the fall in the value of the pound, and its prospects are good. The same is true of tools, which have the advantage of an anti-dumping duty. Merchants who have been handling foreign goods are now sending in numerous inquiries to Sheffield. Some of these inquiries have already materialised into business, and it is expected that the tendency will improve further as the heavy foreign stocks in this country are depleted. There is, at the moment, a price difficulty, as many buyers appear to expect to obtain tools of superior Sheffield quality at the old low German prices, which is out of the question. There is a fair amount of confidence that, as the trade becomes more accustomed to a higher level of quality and prices, increasing business will come to Sheffield, and the outlook for the second half of the year is good.

Smokeless Fuel.

Sheffield has had a good deal to do with the development of the latest process for the production of smokeless fuel by low-temperature carbonisation—that of Commendatore Piero Salerni—as the experimental work was carried out in the laboratories of its University under the supervision of Professor Wheeler. The city is, therefore, hoping to reap tangible advantages from the development of the process, and it has good prospects of success. Commendatore Salerni visited the city last week, and had a conference with civic and commercial leaders. He was able to give the assurance that the plant for working his process would be made in Sheffield. The site for setting up the plant has not yet been decided upon, but the advantages of the city in this respect were brought prominently to the notice of the Commendatore, who agreed that, as far as he could see, there could be no place more generally suitable, and promised to convey the representations to Sir Eric Hambro, who is associated with him in the financing of the process.

New Coke-oven Plant.

The Normanby Park Steel Works of Messrs. John Lysaght, at Scunthorpe, are being reorganised, and a new batch of coke-ovens, which forms part of the scheme, has been brought into operation. The plant is the only one of its type operating in this country, and is on the most up-to-date lines for combining efficiency with economy. It consists of forty-seven ovens, which, having once been charged, need no further solid fuel, as all the firing is done by blast-furnace gas. It will be a considerable factor in reducing costs of production.

Staveley Progress.

The Staveley Coal and Iron Company has in hand a progressive scheme for modernising its collieries, and it has decided to open out immediately the deep, hard seam at Markham No. 4 colliery, Derbyshire, and also entirely to remodel the surface arrangements at the adjoining Ireland colliery. The company has recently been successful in obtaining, under the quota scheme, an allocation of an additional 250,000 tons. The output from the Markham seam will be used chiefly for industrial and coking purposes at the company's Devonshire Works, Staveley, where its interests are now principally centralised. More men will be required at the colliery, though it will naturally be some little time before full production is reached. The developments at the Ireland colliery will include the building of entirely new screens, and that work is being undertaken in order to put on the market a better product and at the same time to cope with the existing position in the house coal industry.

Railway Matters.

The decision of the L.N.E.R. Company to construct in its own workshops during this year fifty-four new locomotives—forty-two tender and twelve tank engines—will bring additional work to its Doncaster establishment, among others. At present, there is quite a substantial programme of new constructional work in progress at Doncaster, thirty-eight new engines being on hand. The works are engaged on a five-days-a-week programme, but only a few of a considerable number of men who were discharged about a year ago have been reinstated. A matter of much interest to railway engineers is the installation of "speed" signals by the L.M.S. Company in connection with an important scheme of widening which it is carrying out at Mirfield. These signals not only tell the driver of a train whether the line ahead of him is clear, but also instruct him as to the speed at which he should proceed. They consist of powerful coloured electric lights, the beam of which is so strong that it is visible at 1000 yards in bright sunlight, and for a considerable distance in dense fog. There are three different aspects of each signal, which indicate the route the train is to take, and also whether its speed is to be "high," "medium," or "low." Another point is that all the lines covered by the light signals are track-circuited, so that every train will automatically protect itself by keeping the signal behind it at "danger" until it has cleared the next signal ahead. The signals cover an area from Heaton Lodge Junction to Thornhill Junction, a distance of 2½ miles.

Raising the "M 2."

The work of raising the submarine "M2," which sank near Portland with such tragic results a fortnight ago, is to be undertaken by Cox and Danks, Ltd., of Sheffield. The firm is, of course, widely known for work of this character, through the success which it achieved in raising the vessels of the sunken German Fleet at Scapa Flow.

Cutlery and Plate.

The state of the cutlery and plate industries, so far as general trade is concerned, is still poor, the year having opened very quietly. There is a large output of stainless table knives, but it is not up to a high standard of activity. The call for pen and pocket knives is moderate. Makers of tool knives are fairly busy, and are looking forward to a considerable development of trade from new sources when the present stocks of foreign goods are exhausted. The strongest departments are those of scissors and safety razor blades, which are not only well employed, but are doing an increasing business. The Rotherham Steel Strip Company, Ltd., has installed an up-to-date plant for producing razor blade blanks, which has just been brought into operation. The blanks are made from cold-rolled steel strip, and are turned out shaped, hardened, and tempered, requiring only the sharpening process to make them ready for the market. They are supplied loose or in coils, cheaply enough to cater for the demand for penny blades. The plant is capable of producing 100,000 blanks per day. The Admiralty is in the market for considerable supplies of cutlery and plate, and has invited tenders for 34,500 solid steel table knives, 113,000 nickel forks, 70,000 nickel silver table and teaspoons, 20,000 mustard, salt and other small spoons, 7300 stainless steel table and dessert knives with E.P. handles, and several hundred carving sets for officers' use, and also 6000 pairs of scissors.

A New Steel Patent.

Brown, Bayley's Steel Works, Ltd., and H. Bull, of Sheffield, have applied for a patent for annealing alloys. The specification states that the liability of intercrystalline disintegration of austenitic stainless steels is avoided by reheating the steel to a temperature between 900 deg. and 920 deg. Cent., so as to throw the major portion of the carbides, or those substances which migrate to the grain boundaries, out of solution in the form of small globules of spheroids. The steels for this treatment have a combined chromium and nickel content of from 25 to 50 per cent., and silicon from 0·5 to 5 per cent. Copper, molybdenum, tungsten, titanium or vanadium may be added up to 5 per cent. A suitable steel contains chromium to at least 20 per cent., nickel from 2 to 20, and carbon up to 0·2 per cent.

NORTH OF ENGLAND.

(From our own Correspondent.)

Traders and Tariffs.

In North of England iron and steel trade circles this week producers and merchants have been chiefly occupied in discussing the probable effects of the imposition of a 10 per cent. tariff on imported iron and steel, and business has been more or less in abeyance. The general opinion is that a 10 per cent. tariff on foreign steel is not enough, and, of course, Indian pig iron, which has been the chief competitor in the pig iron branch of the trade, will continue to arrive duty free. Still, it is undeniable that the broad effect of the tariff will be helpful, especially in the case of semi-finished materials. Producers of iron and steel in this area welcome the opportunity of pressing their claims for a higher tariff before the proposed Imports Board.

Cleveland Iron Trade.

An encouraging expansion in the Tees shipments of pig iron has taken place this month, but the home demand has failed as yet to respond to the stimulus, which it was hoped the Tariff Bill would provide. Consumers are still acting with great caution, but it is hoped that there will be a speedy return to confidence when the tariffs become operative next month. In the meantime, producers have fairly good order books, and are still having to draw upon their stocks to meet requirements. Prices are firm and unchanged, No. 1 Cleveland foundry iron being 61s.; No. 3 G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; and No. 4 forge, 57s.

Hematite Pig Iron.

Quotations for East Coast hematite pig iron vary considerably. Producers are hampered by rather larger stocks than are desirable, but quantities stored are hardly of embarrassing dimensions, and promise to decrease. Merchants possess rather substantial parcels, and are keen sellers. They are under no restriction as to the disposal of their holdings, and are selling on terms which, producers protest, are well below cost of production. Makers look for an upward turn in prices, and hesitate to enter into anything like extensive business. For ordinary mixed numbers 64s. 6d. is a full quotation.

Iron-making Materials.

The foreign ore trade is idle, and 16s. 6d. c.i.f. Tees is purely a nominal figure for best Rubio ore, whilst there are few outlets for blast-furnace coke, which stands at 17s. delivered at the works.

Manufactured Iron and Steel.

Orders for most descriptions of manufactured iron and steel are urgently needed to keep output at its present level, but some slight improvement in demand for one or two descriptions of material is reported. Departments manufacturing constructional steel have a good deal of work to complete, and sheet makers are better employed than of late. Prices are unchanged.

Ship Order for Tees.

The Furness Shipbuilding Company, Ltd., of Haverton Hill-on-Tees, has secured an order for an oil tanker vessel of 2800 tons deadweight, to be built for Canadian owners. Apart from this new order, the builders have three vessels in the course of construction, and one of them, for French owners, is expected to be launched next week.

The Coal Trade.

It is difficult to find any quickening in the demand for coal. While new markets for Northumberland and Durham coal have been opened up, as a result of the fall in the value of the pound—such as Jamacia and the United States—the depreciation of the value of the pound, as well as the financial difficulties of many European countries, has led to more restrictions being put on our coal exports. Germany is the latest addition to the countries which, for one reason or another, curtail their imports from Britain. There is to be a cut in coal imports from Britain of about 150,000 tons a month. As this district does a large trade with Germany, the decision is particularly unwelcome. Some of the Northern collieries are having a bad time just now, and even the best placed cannot see very far ahead in the matter of stems. The supply of orders is not regular, and that is causing some anxiety for the remainder of the month. The season of heaviest consumption is advancing, and no particular demand is expected, even though the weather has entered upon a very cold spell, as big users at home and abroad have very large stocks of fuel, owing to the recent unusually mild weather. No sign can be seen of any revival in the Northumberland steam coal trade. The position remains quiet, but on the whole steady. For the second half of the month fitters could handle very substantial additional demands. Output is kept down to requirements, and prices quoted remain at the recent level. Best steam coals are quoted at 13s. 6d., Tyne prime at 13s., and Durham best at 15s. For small coal the position is easy. Best classes are at 8s. 6d., Tyne prime 9s., and good secondary 8s. The general lack of new business and the prospects ahead appearing poor, in view of increasing restrictions on imports into many Continental countries, impart a very dull tone to the Durham market. Very little change in values is to be noted, but so little definite business is astir that prices are merely quoted at the schedule. Best Durham gas coals are at 14s. 6d., secondary 13s. 6d., and Wear special gas 15s. Coking qualities are neglected, the tone remaining easy for unscreened at 13s. to 13s. 9d., and for small at 12s. 6d. to 13s. 3d. There is no improvement in the bunker trade, best descriptions being just moderately booked up and offering freely at 13s. 9d. to 14s., with seconds plentiful at 13s. The market maintains a good tone for gas coke qualities, and production is fully taken up. Stocks are at a low ebb, and prices are holding firm at 19s. for best qualities. Coke nuts are absorbed up to the full output, and continue to meet a good forward inquiry at 19s. to 21s. Patent oven coke is moving slowly with the undertone easy at 16s. to 17s. Superior coke is steady at 18s. to 21s.

SCOTLAND.

(From our own Correspondent.)

Quiet Markets.

The steel, iron, and coal markets continue without much encouragement, buying on the whole being of an extremely quiet nature. At the same time, it may perhaps be said that there is noticeable a little more confidence which probably is due to the hope that now that the Government action with regard to tariff proposals is at least partially known, some business held up pending such decisions may soon be placed, and that those proposals may ultimately prove beneficial to trade in general.

Steel.

Inquiries on export account are still more prominent than those on home account. Export orders, too, take a more prominent part. Home buying is confined to small quantities, and practically nothing in the nature of an extensive specification has been mentioned. Heavy steel is a very quiet department, plates and sections being neglected and mills having most inadequate employment. The position of sheets is much more stable at present. Heavy descriptions perhaps are not particularly well placed, but most producers are fairly well off in the lighter descriptions. Galvanised sheets, too, have a fair turnover and inquiries are numerous. It is hoped, however, that producers may not be faced with increased costs of production in the nature of dearer raw materials, and probably some provision will be made for this in the tariff

proposals. Otherwise, dearer quotations would be inevitable. Tube makers remain quiet. Prices generally are unchanged.

Iron.

The bar iron trade still lacks any sign of increasing business, despite the recent price reduction. Makers of re-rolled steel bars, too, make little progress, notwithstanding considerable price cutting. Production is below normal, and orders are of a hand-to-mouth description, demands seldom producing work for more than one day ahead. Bar iron is unchanged in price, and re-rolled steel bars are quoted £6 5s. home and £6 2s. 6d. per ton export.

Pig Iron.

Conditions in pig iron can only be described as dull. Production is severely limited, but ample. During the past week cargoes amounting to over 1000 tons arrived in the Clyde from Millom, while shipments from Glasgow amounted to 173 tons, of which total 113 tons went abroad, compared with 607 tons (329 tons foreign) in the same week last year. The number of furnaces in blast in Scotland remains at five.

Scrap.

The demand for scrap shows a further decline, and prices are weakening, cast iron machinery being now quoted 52s. 6d. to 55s. and heavy steel 40s. to 42s. 6d. per ton.

Coal.

The coal trade is still dominated by mild weather conditions at home, and restricted foreign demands, due to exchange difficulties, and to the high French import duties. In the shipping department commitments are very light, both in large coal and washed stuffs. The former, apart from Lanarkshire splints, are becoming plentiful and prices easier. Washed materials, especially trebles and doubles, are still weakening. Business is almost entirely of a day-to-day nature, forward transactions being conspicuously absent. Aggregate shipments amounted to 215,145 tons, against 256,039 tons in the preceding week, and 197,517 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

NOTHING of a favourable character has taken place during the past week to influence the coal trade of this district. There was a time when the mere threat of hostilities in any part of the world caused a flutter in local coal and shipping circles, but such is the change in world conditions, that the troubles in the Far East, advanced as they are, have failed to have the slightest effect. Developments that have occurred of late, can only be described as doubtful so far as the interests of this district are concerned. Views held locally are very mixed regarding the effect of the Government's tariff proposals, and news is anxiously awaited as to whether they are to apply to imports of pitwood and other timber and to iron ore. Based on last year's imports of pitwood and pit props, and allowing for a possible slight reduction in the quantities for the current year, it has been estimated that a 10 per cent. duty would yield approximately £100,000. The coal industry is, of course, very much interested in anything which is calculated to advance the costs of production. Scarcely a week passes but what something fresh comes to hand of restrictions being imposed abroad to the detriment of the British coal export trade. The latest concerns the intimation which Hamburg coal importers have received that their annual quota was to be reduced as from the beginning of this month, viz., from 1,870,000 tons to 1,570,000 tons. This is a reduction of 300,000 tons per annum, and as a goodly portion of their coal imports are from the North-East Coast, this will ultimately reflect upon South Wales. As regards the French restrictions, a deputation from the Mining Association of the Coal Exporters' Association was in Paris in the early part of this week to see the French Government, and hopes are entertained that, as the outcome of that interview, some benefit will accrue, and that some modification of the restrictions imposed on British coals will be secured. The conditions prevailing at the moment are certainly bad. Last week's shipments of coal and coke, according to the Great Western Railway Company's returns, were very unsatisfactory, as the total was only 363,735 tons, which was 38,385 tons less than the preceding week and 122,090 tons below the total for the corresponding period of last year. The loading position was unquestionably disappointing all through the week, and on Saturday the total of vacant berths at the various docks was forty-five. As the result of arrivals of tonnage over the week end the number was reduced to twenty-seven, but on Tuesday the figure was back to forty-one. Unfortunately, the volume of chartering of late has been wholly unequal to the requirements of collieries, most of which are working very irregularly. The inquiry all round is very slow; in fact, new business is negligible. In the case of the recent inquiry from the Norte Railway of Spain for 15,000 tons of steam coal for fairly early delivery, it now appears that the business has not actually been placed, the reported reason being an adverse alteration in the exchange rate. News is now awaited whether it is the intention of the Norte Railway to come into the market later when the conditions are more favourable and seek fresh tenders. So far as other contract business is concerned, the Norwegian State Railways are inquiring for 30,000 tons of large coal to be delivered by the end of April, and it is possible that part of that business may come to South Wales. Meantime, orders on the market are quite insufficient to absorb the tonnage being offered, with the result that outward freights for some directions have this week touched fresh low levels.

New Coal-loading Appliances.

The Great Western Railway Company is to be commended for improving its coal-loading appliances, particularly in such times as the present, when the outlook is so doubtful. This week, the first of five new electric coal belt conveyors, which are to replace the six Lewis Hunter cranes at the Roath Dock, at Cardiff, came into operation, and the first steamer to be loaded was the s.s. "Podmladak." With this new appliance, the coals from the loaded wagons are discharged on to a moving conveyor and carried to the ship's hold. At the end of the conveyor is an escalator and by its means the coal is carried right to the bottom of the ship's hold. A feature of the installation is a gravity crossing for the clearance of empty wagons. The loaded wagon is placed on the turntable and the coal is tipped into a bin capable of holding 40 to 50 tons. The wagon then runs off the tippler to inclined rails and on to the empty tip roads. With this new appliance it is estimated that coals can be loaded at the rate of 1000 tons per hour. It is the intention of the company to proceed immediately with the construction of a second appliance and eventually equip the whole of the coal-shipping side of the Roath Dock with five of them altogether.

New Grain Mill.

It is reported that Spillers, Ltd., intends to erect a new grain mill at Cardiff. It is to be equipped with the most modern plant and is to take the place of the existing mill at the West Dock and will be constructed at the top end of the Roath Dock, where larger vessels can be dealt with. At the present time grain brought into Cardiff in large steamers is unloaded into barges in the Queen Alexandra and Roath Docks, and then taken to the mill at West Dock. The new mill will obviate this transference.

Coalfield Items.

A conference of representatives of colliery craftsmen and mechanical workers, who are members of the South Wales Miners' Federation, was held at Cardiff on Saturday for the first time. One hundred and twenty delegates, stated to be representative of 12,716 workers, attended. A resolution was passed strongly protesting against the "scandalously low wages now paid to skilled workmen," and instructing the executive council to approach the coalowners with a view to improving present rates and, failing agreement, that it be authorised to press that the workmen's claims shall be referred to an Industrial Court under the Industrial Conciliation Act; further, that the Miners' Federation should press forward a demand for a new Coal Mines Minimum Wage Act, applicable to surface and underground workmen, embodying the principle of minimum wage rates equivalent to pre-war wages, plus the increase in the cost of living Last week-end, there was a lightning strike at the Bedwas Colliery, where friction has prevailed for some time past. There was no work on Sunday night or Monday morning, but the men decided to resume on Monday night and instructed their committee to tender fourteen days' notice with a view to getting their grievances remedied.

Coal-trimming Proposals.

Negotiations are still proceeding between the employers' representatives and the men's leaders concerning the proposals of the shipowners for the control of the working of the coal-trimmers so as to secure improved despatch of steamers loading at South Wales ports. Newport trimmers on Sunday last rejected the proposals by a large majority and there is to be a mass meeting of the Cardiff, Penarth and Barry coal-trimmers on Sunday next to consider the scheme by which the control would be solely in the hands of the Employers' Clearing House. The coal-trimmers' executive met at Cardiff on Monday to discuss the situation, but issued no report. It is understood, however, that it is negotiating with the representatives of the shipowners in order to obtain certain assurances on various points, and much depends upon the executive's advice as to what the men decide next Sunday.

Wages in Steel Trade.

The South Wales Steel Association meeting at Swansea on Monday decided to continue for the next quarter the payment of *ex-gratia* bonuses to the lower-paid workmen in the industry. These bonuses have been paid for some years past.

Current Business.

The steam coal market displays no new feature. The demand for all grades is inadequate to the needs of collieries, which continue to lose a considerable amount of working time. Prices are at the minima. Coke is quiet and patent fuel makers are short of orders. Pitwood is a slow market owing to the reduced requirements of collieries. Portuguese pitwood is round about 21s. 6d. to 22s., and French wood is quoted at about 24s.

CATALOGUES.

HARRY HEYMANN, Ltd., 5, Union-street, Bradford.—A booklet illustrating a number of instruments for conveying and pouring liquids of all types.

JAMES HOWDEN AND CO. (Lond.), Ltd., Caxton House, London, S.W. 1.—A 30-page brochure of the various types of fans supplied by the firm.

BRUCE, PEEBLES AND CO., Ltd., Edinburgh.—Leaflet No. 161A of synchronous induction motors for power factor improvement and power application.

"SENTINEL" WAGGON WORKS, Ltd., Iddesleigh House, Caxton-street, S.W. 1.—An 80-page book on the "Sentinel" patented locomotive and its work.

EVERSHED AND VIGNOLES, Ltd., Acton-lane Works, W. 4.—Publication 167c, on the "Bridge Meg" testing set, and a leaflet on the "Meg" earth tester.

CHURCHILL MACHINE TOOL COMPANY, Ltd., Broadheath, near Manchester.—Pamphlet U.T.C. 6 on motor-driven universal tool and cutter grinding machines.

DOBBIE, MCINNES AND CLYDE, Ltd., 57, Bothwell-street, Glasgow.—A wall chart for rapid and easy determination of I.H.P. from M.I.P. and engine speed.

FREDK. BEABY AND CO., Ltd., 352–364, Euston-road, N.W. 1.—A sixty-page brochure illustrating the large range of sheet metal products in which the firm specialises.

A. REYROLLE AND CO., Ltd., Hebburn-on-Tyne.—Pamphlet 837 on the inverse-time limit over current relay-induction type, with adjustable definite minimum time setting.

WELLINGTON TUBE WORKS, Ltd., Great Bridge, Tipton, Staffs.—Catalogue No. 62, a ninety-page book of the firm's products, which include tubes and fittings of all kinds.

CALORIZING CORPORATION OF GREAT BRITAIN, Ltd., 32, Farringdon-street, E.C. 4.—Brochure 1058, describing the Calorizing process and illustrating a few of its applications.

W. H. WILLCOX AND CO., Ltd., 38, Southwark-street, S.E. 1.—Particulars of wrought steel pulleys from 3in. to 48in. diameter. These pulleys are now made with the arms are welded to the rims.

EDUCATIONAL INTELLIGENCE.

UNIVERSITY OF LONDON: ADVANCED LECTURES IN PHYSICS.—A course of two lectures on "Physical Lines of Electric Forces and their Application to the Interpretation of the Electromagnetic Field," will be given at University College, London, Gower-street, W.C. 1, by Sir Joseph J. Thomson, O.M., F.R.S., Master of Trinity College, Cambridge, at 5.30 p.m. on Thursdays, February 18th and 25th, 1932. The lectures, which will be illustrated with lantern slides, are addressed to students of the University and to others interested in the subject. Admission will be free, without ticket.

LAUNCHES AND TRIAL TRIPS.

STEEL LIGHTER; built by Richard Dunston, Ltd., Thorne, Yorkshire, to the order of Hull owners; dimensions, 75ft. by 20ft. by 9ft. 6in.; to carry 1000 quarters of grain; launch, January 23rd.

EL KANTARA, twin-screw steamer; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Compagnie de Navigation Mixte Marseilles; dimensions, 400ft. by 53½ft.; to carry passengers and cargo. Engines, turbines (Parsons type); constructed by the builders; launch, February 8th.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—On Thursday, February 4th, the annual dinner of the Institution of Electrical Engineers was held at the Connaught Rooms, when the President, Captain J. M. Donaldson, occupied the Chair. Messages conveying best wishes to the Institution were read by the President from the Italian Electrotechnical Association and the Belgian Society of Electricians. In proposing the toast of the Institution, Mr. Pybus, Minister of Transport, said that Britain alone among the industrial countries of the world showed in 1931 an increase in the production of electricity by public supply undertakings. During the past five years the expansion in output of electricity from public supply undertakings in Great Britain was 35 per cent. compared with 15·3 per cent. in the United States and 18·5 per cent. in Germany.

A VISIT OF SOUTH AFRICAN STUDENTS TO THE ENGLISH ELECTRIC COMPANY'S STAFFORD WORKS.—Under the leadership of Professor W. G. Sutton, Dean of the Faculty of Engineering at the University of Witwatersrand, a party of twenty-three South African students was entertained by the English Electric Company at Stafford on January 25th. Upon their arrival they had lunch with the managing director, Mr. G. H. Nelson, other members of the staff, and several South Africans who are serving their apprenticeship at Stafford Works. During their tour through the shops the students showed the greatest interest in the wide range of products, and they are said to have been unanimous in the opinion that it was the best laid out and most actively occupied of the many works they had visited since they arrived in England on December 28th. It was with no little difficulty that the visitors were persuaded to terminate their inspection of the machinery and apparatus in order to have tea. Mr. G. H. Nelson again presided, and in a short address welcomed the students. He outlined the traditions and activities of the English Electric Company, and emphasised the vast possibilities that lay before Great Britain, South Africa, the Dominion and Colonies in co-operating to meet each other's mutual needs to the best advantage of all the members of the Commonwealth. The designers and workpeople of this country, he said, inherited a long tradition of skill which could not be acquired by other countries in a short time, and the full benefit of that experience and craftsmanship should be made use of by other countries. Professor Sutton, in reply, expressed the appreciation of the party at the hospitable reception that had been given them, and of the instructive nature of the visit, and endorsed Mr. Nelson's views concerning the co-ordination of the special attributes of the great nations that had such close ties with Great Britain. A lantern address was then given by Mr. H. S. Carnegie, of the engineering department of the company, in which he outlined the chief features of the important contract now in hand for the equipment of the steel works of the South African Iron and Steel Industrial Corporation at Pretoria.

ROLLING LARGE SECTIONS AT FRODINGHAM.—Until recently the Frodingham Iron and Steel Company, Ltd., of the United Steel Companies, Ltd., omitted certain standard beam sections from its list, owing to practical difficulties in rolling some of the larger sections in its existing mill. It has recently determined to place itself in a position to supply the complete range of British standard beams, and is now rolling 22in. by 7in. and 24in. by 7½in. beams. This development necessitated certain mill alterations, and as the finishing mill is a 30in. mill, it will be realised that the rolling of these large sections from a mill of this size is a technical achievement of some interest. The large section mill at Frodingham comprises a 36in. cogging mill and a 30in. finishing mill of three stands. To roll successfully the 22in. and 24in. beams, it was found necessary to design a special pair of cogging rolls, so that part of the work generally done in the roughing-passes in the finishing mill could be done in the cogging mill. The advantages of this method of working are manifest, while the only disadvantage is the necessity of changing the cogging rolls every time 22in. and 24in. beams are rolled. Efforts were directed, therefore, to reduce the time required for roll changing by certain alterations in the design of the mill. This end was accomplished to a very marked degree. The three pairs of finishing rolls were so designed that all the passes are alternately close and open on the flanges, thereby producing a section true to shape. The process of rolling the beams is as follows:—The ingot is rolled down and shaped in the cogging mill. The ends are sheared and the shaped bloom is placed in a reheating furnace. It is withdrawn from this furnace at a suitable temperature and finished to size in the finishing mill. The 24in. by 7½in. beams can be rolled in weights ranging from 90 lb. to 108 lb. per foot, and the 22in. by 7in. beams in weights ranging from 75 lb. to 88 lb. per foot. Three pairs of rolls were designed for the 22in. by 7in., and three pairs for the 24in. by 7½in., together with one pair for the cogging mill, making altogether seven pairs of rolls, aggregating 160 tons. These rolls are of forged steel, and were made by the associated firm of Steel, Peech and Tozer, and delivered complete in three months.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	16/6 to 20/–
(1) Spanish	17/– to 21/–
N.E. Coast—	
Native	18/– to 21/–
Foreign (c.i.f.)	16/6 to 17/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 8 6	—
No. 1 Foundry	3 12 0	—
No. 3 Foundry	3 9 6	—
N.E. Coast—		
Hematite Mixed Nos.	3 4 6	3 4 6
No. 1	3 5 0	3 5 0
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
Midlands—		
(c) Staffs.—	(*Delivered to Station*).	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
„ „ Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (*a*)	—
	4 0 6 (*b*)	—
	4 5 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 5 0	—
Common Bars	10 10 0	—
Best Bars	11 0 0	—
Double Best Bars	11 10 0	—
Treble Best Bars	12 0 0	—
Lancs.—		
Crown Bars	9 15 0	—
Second Quality Bars	8 5 0	—
Hoops	12 0 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	9 5 0 to 10 7 6	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 7 6	—
Gas Tube Strip	10 10 0 to 10 12 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	9 0 0	8 10 0
„ „ (Land)	—	—
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 10 0	7 10 0
Sheets (Gal. Cor. 24 B.G.	10 5 0	9 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
Manchester—		
Bars (Round)	9 7 6	—
„ (Small Round)	7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	8 15 0	—
Sheffield—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	6 0 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
Midlands—		
Small Rolled Bars (all British)	7 5 0 to 7 15 0	—
Small Re-rolled Bars	6 12 6 to 6 15 0	—
Billets and Sheet Bars	5 7 6 to 5 10 0	—
Galv. Sheets, f.o.b. L'pool	9 5 0 to 9 7 6	—
(2) Staffordshire Hoops	9 10 0	—
(*d*) Angles	8 7 6	—
(*d*) Joists	8 15 0	—
(*d*) Tees	9 7 6	—
(*d*) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 12 6	—

NON-FERROUS METALS.

Swansea—		
Tin-plates, I.C., 20 by 14	f.o.b.	14/3 to 14/9
Block Tin (cash)		138 5 0
„ (three months)		141 0 0
Copper (cash)		36 6 3
„ (three months)		36 3 9
Spanish Lead (cash)		14 10 0
„ „ (three months)		14 12 6
Spelter (cash)		13 17 6
„ (three months)		14 6 3
Manchester—		
Copper, Best Selected Ingots		40 0 0
„ Electrolytic		44 0 0
„ Strong Sheets		72 0 0
„ Tubes (Basis Price), lb.		0 0 11
Brass Tubes (Basis Price), lb.		0 0 9½
„ Condenser, lb.		0 1 0
Lead, English		16 2 6
„ Foreign		14 15 0
Spelter		14 5 0
Aluminium (per ton—raw ingot)		£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/4 per lb.	
Ferro Tungsten	2/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 12 6	7/–
„ „ 6 p.c. to 8 p.c.	£23 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£22 15 0	6/6
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£36 10 0	10/–
„ „ „ 1 p.c. carbon	£43 10 0	12 –
„ „ „ 0·70 p.c. carbon	£52 10 0	13/–
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	3/1 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
„ „ „	£11 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£9 15 0 scale 5/– per unit	
„ „ 75 p.c.	£15 10 0 scale 7/– per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£250 to £255	
Ferro Cobalt	10/– per lb.	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	13/– to 13/3
„ „ Ell	14/3
„ „ Splint	14/3 to 16/3
„ „ Trebles	13/–
„ „ Doubles	11/–
„ „ Singles	9/6
Ayrshire—	
(f.o.b. Ports)—Steam	13/–
„ „ Jewel	17/–
„ „ Trebles	13/–
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	12/– to 13/–
Screened Navigation	16/6
Trebles	12/6
Doubles	11/–
Singles	9/9
Lothians—	
(f.o.b. Leith)—Best Steam	12/–
Secondary Steam	11/9
Trebles	12/9
Doubles	11/–
Singles	9/6

(8) N.W. Coast— ENGLAND.

Steams	21/9
Household	32/6 to 51/6
Coke	20/6 to 22/6
Northumberland—	
Best Steams	13/9
Second Steams	12/3 to 12/6
Steam Smalls	8/6 to 9/–
Unscreened	12/6 to 13/–
Household	27/– to 39/–
Durham—	
Best Gas	14/6
Second	13/6
Household	25/– to 37/–
Foundry Coke	24/–
Sheffield—	Inland.
Best Hand-picked Branch	26/6 to 27/6 —
South Yorkshire Best	23/6 to 24/– —
Derbyshire Best Bright House	19/– to 20/6 —
Best House Coal	22/– to 23/– —
Screened House Coal	19/– to 20/6 —
Best Screened Nuts	17/– to 18/– —
Small Screened Nuts	14/6 to 15/6 —
Yorkshire Hards	16/– to 18/– —
Derbyshire Hards	16/– to 18/– —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	7/– to 8/6 —
Smalls	5/6 to 6/6 —
Blast-furnace Coke (Inland)	12/– to 12/6 on rail at ovens
Furnace and Foundry Coke (Export), f.o.b., 18/– to 18/6	

Cardiff— (9) SOUTH WALES.

Steam Coals :	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/– to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/–
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/– to 13/6
Ordinary Smalls	11/– to 13/–
Washed Nuts	19/– to 27/–
No. 3 Rhondda Large	19/9 to 20/–
„ „ Smalls	15/– to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	15/6 to 16/–
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	22/6 to 36/6
Furnace Coke (Export)	17/– to 18/–
Patent Fuel	19/– to 19/3
Pitwood (ex ship)	21/6 to 24/–
Swansea—	
Anthracite Coals :	
Best Big Vein Large	36/– to 38/6
Seconds	27/– to 32/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 43/6
Nuts	40/– to 42/6
Beans	29/6 to 32/6
Peas	18/– to 21/–
Breaker Duff	8/6 to 9/6
Rubbly Culm	8/3 to 8/9
Steam Coals :	
Large	20/– to 20/6
Seconds	18/– to 20/–
Smalls	11/6 to 13/–
Cargo Through	16/– to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate; Joists (minimum), 22/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

Shipbuilding.

THE suspension of work on the liner "Champlain" at the Penhoët shipyard, to be followed by the holding up of the 73,000-ton liner, was so serious a matter for Saint-Nazaire that, after receiving deputations from that town, the Prime Minister presented the case again to the Finance Commission of the Senate, which had rejected the Government scheme to refloat the Compagnie Générale Transatlantique and agreed only to an advance of 50 million francs during a period of six months, when the Government would be required to introduce a Bill for a general organisation of the maritime services receiving State subsidies. The temporary advance was subject to conditions that could hardly be fulfilled, so that the decision of the Finance Commission really meant that no further aid would be forthcoming. The Prime Minister confirmed to the Finance Commission that the Government had definitely withdrawn its proposal to refloat the company, and he appealed for an unconditional advance to allow of work being resumed on the ships under construction. The Commission was not disposed to devote public funds to the construction of the two liners alone, and it recommended that the Treasury should be authorised to advance 110 million francs for the services of the Compagnie Générale Transatlantique during the next six months, this being conditional on the Government adopting some plan to ensure a continuance of the services when that sum was expended. The amount thus authorised will leave little, if anything, for the construction of the liners. Another 90 million francs will have to be found if full work is to be continued on the two ships. The seriousness of the situation will be revealed in a report upon the merchant marine to be presented shortly to the Chamber of Deputies in connection with the Budget. It criticises mistakes that have been made in French shipbuilding in the past, and recommends that a definite plan should be laid down for a limited number of ships on subsidised lines which will deal with the traffic under the most suitable and economical conditions. The ships so far built have been either too slow for competitive traffic or too fast and luxurious and, consequently, too costly. The two liners at Penhoët come within the latter category, which accounts for the official hesitation to hurry their construction under present conditions. According to a report of the Ministry of Merchant Marine, however, work was resumed on the two liners last Monday.

The Steel Position.

Steel production in France has declined less than in other countries, and it is now a question whether the contraction of output will not rapidly accelerate. The 10 per cent. import duty on iron and steel into Great Britain would not of itself shut out consignments from France, but with the depreciation of sterling it is feared that it will amount to prohibition, in which event steelmakers see little opportunity of disposing of their surplus supplies. Last year French producers exported to Great Britain 423,000 tons of pig iron, 388,000 tons of blooms and billets, 1,355,000 tons of bars, 113,000 tons of hoops and 220,000 tons of sheets and plates. The home market is at present quite unable to absorb all this material. Notwithstanding the efforts to put in hand a vast programme of public works, the demand for rolled steel has shown little improvement, and a disquieting feature is the competition from Belgium, which has become so threatening that the home comptoirs, being unable to maintain prices, are agitating for an extension of the import quota system to semi-manufactured steel, joists and bars, in the same way as is done in the case of hot rolled sheets. Such quotas are almost inevitable in view of the operations of the national Steel Pact, which aims at adjusting the production to the demand and keeping prices at a profitable level. There is still some delay in completing the national Steel Pact owing to the attitude of a producer in Lorraine, who is holding out for a larger share of foreign trade. It is expected, however, that this difficulty will be settled shortly, and when the sales organisations are extended to all descriptions of rolled iron and steel, the national Steel Pact will be able to deal with the home and colonial trade with no fear of competition, except from the quotas allotted to foreign countries.

The Steel Cartel.

The meeting of the Steel Cartel in Paris last week again failed to reach an agreement on account of the inability of Belgian steelmakers to settle their own differences. There are two or three "outside" firms in Belgium who refuse to join the Cartel unless they are assured of a higher quota than is offered them, and the Belgians have endeavoured to meet these claims by obtaining an increased quota for Belgian steel. The French refuse their consent to any such increase, and the reconstitution of the Cartel is therefore being held up until the Belgians accept the percentage agreed upon by all the other producing countries. It appears unlikely that there will be fresh developments until the French impose import quotas on steel, when the Belgians may have to join the Cartel or find themselves less favoured as regards the quantities of steel which they will be allowed to export to France.

The Sautet Dam.

The dam being constructed at Sautet, about 43 miles from Grenoble, is of novel design and is noteworthy for its height. At that point the river Drac has made a deep and narrow gorge through the rock. This gorge is being blocked up to form a reservoir 875 acres in extent and containing about 130 million cubic metres of water. The main barrage is being recessed into the sides of the gorge, and there will be a spillway forming a second barrage lower down. The height of the main barrage above the spillway will be 90 m., and the lower dam will have a height of 40 m., thus giving a total height of 130 m. The Sautet barrage will be capable of producing about 185 million kWh a year.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

363,809. December 11th, 1930.—THE COOLING OF PISTONS, *L. Mellersh-Jackson, 28, Southampton-buildings, Chancery-lane, London, W.C.2.*

For the purpose of cooling the head of the piston of internal combustion engines, the inventors arrange a cavity, which is partly filled with a salt, such as potassium nitrate, which melts at a temperature of about 300 deg. Cent. At starting the engine, the salt remains solid and clear of the piston head, which consequently warms up quickly and helps in rapid starting. When the engine is running, the salt melts, and by

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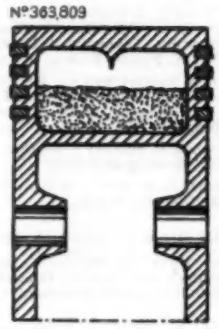

splashing about in the cavity conveys away the heat of the piston head to the cylinder walls. The piston is made of a copper-beryllium alloy, containing 13 per cent. of beryllium. It is generally advisable to make the piston bottom or the whole piston form a beryllium alloy, and then subject the work to a tempering process, which consists, essentially, in a rapid cooling from temperatures between, say, 700 deg. to 1200 deg. Cent., according to the composition of the alloy in question, and to a subsequent artificial ageing at lower temperatures between, say, 250 deg. to 500 deg. Cent.—*December 31st*, 1931.

DYNAMOS AND MOTORS.

363,756. October 16th, 1930.—DYNAMO-ELECTRIC MACHINES, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C. 2, and Robert Orsettich, of the General Electric Company, Witton, Birmingham.

A method is described in this specification of fastening the magnetic poles of an alternator to the magnet wheel, and the scheme is claimed to be particularly advantageous in connection with large, high-speed alternators with salient poles. The magnet wheel has recesses A and the root D of each pole B fits

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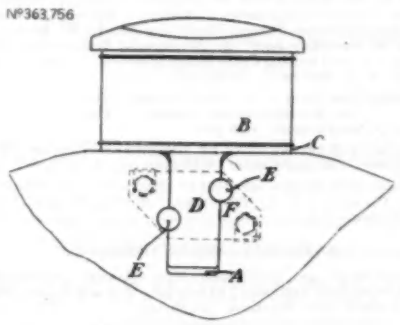

into one of these recesses. Under each pole there is a flange C, which beds the pole on the magnet wheel. At the sides of the pole roots, there are semi-circular recesses, which register with similar recesses on the rotor body. These recesses or keyways are conveniently made by drilling whilst the pole is in position, and cylindrical keys E are subsequently driven into the poles. The ends of the keys are then covered by plates which are secured to the magnet body by bolts provided with locking washers.—*December 31st*, 1931.

TRANSFORMERS AND CONVERTERS.

363,606. May 19th, 1931.—MAGNETIC CORES, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.

The magnetic cores described in this specification are suitable

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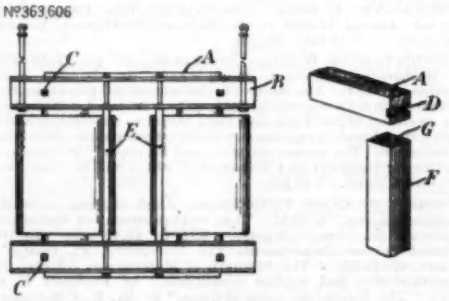

for transformers or reactors, and the object of the invention is to prevent undue reluctance owing to imperfect butt joints. The yokes A are provided with clamps B, each yoke and its clamps being held together by bolts C, and the bolts engage with notches D in the ends of the yokes to prevent relative displacement. The rods E, extending between the clamps B, hold the yokes tightly against the opposite ends of the winding legs F. The reluctance at the joints is reduced by providing each joint with a small quantity of magnetic material G consisting of a fine magnetic iron powder or filings mixed with Portland cement and water or alcohol.—*December 24th*, 1931.

MEASURING AND TESTING INSTRUMENTS.

363,785. November 13th, 1930.—FREQUENCY METERS, *Kolster-Brandes, Ltd., of Cray Works, Sidcup, Kent.*

In accordance with this invention, a piezo-electric crystal A is connected in an oscillating circuit, as shown, and is shunted by a high resistance B. The oscillating circuit includes a tuned branch C, adjusted so that the valve will operate to sustain oscillations at the frequency of the crystal. The output circuit includes a telephone receiver D, and a switch E, which renders the tuned branch circuit C effective or ineffective to sustain oscillations at the frequency of the crystal. For the purpose of illustration it may be assumed that the crystal is ground for a frequency of 50 kc, and the branch circuit C is adjusted to a corresponding frequency, whilst the coupling circuits G respond to a frequency over a range of 3000 to 4000 kc. As the inductances G are small, the impedance to low-frequency oscillations of the crystal

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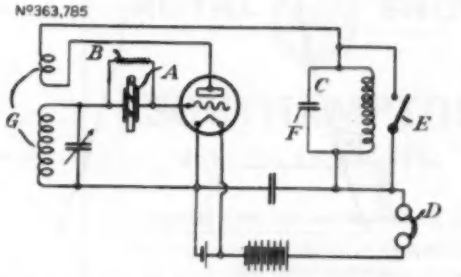

is negligible, and if the capacity F is relatively large, the impedance to the high-frequency oscillations developed by the coupled circuits G and C is negligible. For that reason the valve circuits may oscillate at two frequencies simultaneously. As the high-frequency circuit is tuned through harmonics of the low-frequency oscillations, beat tones are heard in the telephone D, *i.e.*, near 3000 kc, 3050 kc and 3100 kc, &c. As the crystal frequency is permanent, it provides a means of calibrating the oscillator without any additional apparatus. On closing the switch E the crystal ceases to oscillate and the high-frequency circuit may be used, either for the purpose of measurement, or as a heterodyne or driver. During the course of measurements, it becomes desirable to eliminate the beat tones, which is readily accomplished by closing the switch E. Upon the opening of the switch, however, the calibration of the meter is readily checked by the occurrence of the beat tones for selected settings of high-frequency circuits.—*December 31st*, 1931.

MISCELLANEOUS.

363,377. August 6th, 1930.—MERCURY ARC RECTIFIERS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.*

A mercury arc rectifier constructed in accordance with this invention is claimed to have a relatively high-current capacity. A is the usual evacuated vessel containing the cathode B and the anode D which are insulated from the walls of the vessel and the chamber C surrounding the anode. In the chamber C a

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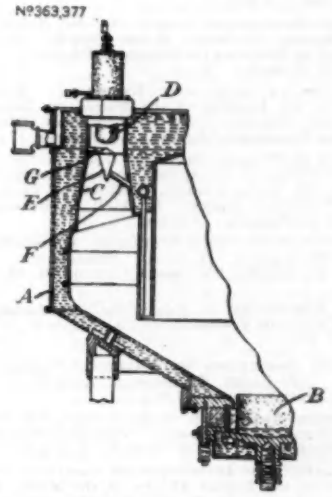
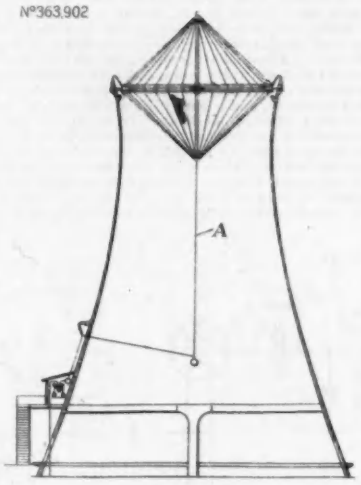


hollow conical member E is mounted in such a manner that the apex is pointed toward the cathode. This member is supported by two pipes F and G leading through the walls of C and attached respectively to the apex and the base of the member E to permit a circulation of cooling fluid through that member. The largest diameter of the member E and its overall length are such that the distance between it and the wall of passage C satisfies the conditions for de-ionisation and for the collision of electrons with mercury atoms.—*December 7th*, 1931.

363,902. February 24th, 1931.—COOLING TOWERS, L. G. Mouchel and Partners, Ltd., 36–38, Victoria-street, Westminster, and G. Prud'Homme, 9, Place Kléber, Strasbourg, France.

In order to prevent the emission from cooling towers of water vapour so saturated that it may cause a local rain, which would be a nuisance and result in the loss of water, the inventors arrange an electrified grid at the top of the tower. This grid takes the form of two cones of wire netting, which are suspended on insulators and are charged through the pendant conductor A. No mention is made of the voltage necessary, but it is stipulated that the angle of the apex of the cone must be very near to 90 deg. It is necessary, in order to ensure that the water shall trickle along the wires of the network, that the angle of the wires should be at least 42 deg. to the horizontal. The mesh may probably be of the order of from 40 mm. by 40 mm. to 70 mm. by 70 mm., the exact size being determined according to the electrical voltage obtainable. In use, if, for example, two thick wires are used—say, eight-tenths of a millimetre—their perimeter will be double, as a result of which the friction of the water drops will be at least double, since the drop will become

less spherical, and it will not slide along the wire so well. Furthermore, the thicker the wire the more liable it is to develop distinct waves and kinks, causing appreciable changes of slope. Finally, there will be a tendency for the drop to fall at the crossing of two wires. With very thin wires, on the other hand, the drop encircles the wire, slides rapidly, and will not fall with a junction with a horizontal wire. If a netting with a lozenge-shape mesh is employed, one of the directions of the wires should follow the line of greatest slope. If a netting having only a square or rectangular mesh is employed, then care must be taken



not to place either of the directions of the wires to follow the line of greatest slope, as in that case the other wires would be horizontal and the drops would not travel along them. Neither must the netting be placed so that the two sets of wires are at equal angles to the direction of greatest slope, because then both will only be at an angle of about 30 deg. to the horizontal. One set of wires must be placed nearly following the direction of greatest slope, the other wires being nearly horizontal, but having, nevertheless, sufficient slope to induce the drops forming thereon to travel to the adjoining wire of greater slope, which it will quickly follow.—*December 31st*, 1931.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Tuesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

BRITISH WOOD PRESERVING ASSOCIATION.—R.C.A. Theatre, Film House, 142–150, Wardour-street, W. 1. Film, "Preservation of Timber." 3 p.m.

CHEMICAL ENGINEERING GROUP.—In the Rooms of the Chemical Society, Burlington House, Piccadilly, W. 1. "A New Method for Measuring the Mechanical Properties of Metals," by Mr. L. H. Hounsfield. 8 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—In the Building of the Manchester Literary and Philosophical Society, 36, George-street, Manchester, "Mechanical Breakdown," by Mr. L. W. Schuster. 7 p.m.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—In the Non-ferrous Section of the Applied Science Department of the University, St. George's-square, Sheffield. "Spectrographic Methods of Chemical Analysis," by Dr. H. W. Brownsdon and Mr. E. H. S. van Someren. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: LONDON STUDENTS' SECTION.—Savoy-place, Victoria Embankment, W.C. 2. "Mercury-arc Rectifier Phenomena," by Mr. H. H. Taylour. 6.15 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Epicyclic Transmissions," by Major W. G. Wilson. 7.30 p.m.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Queen's Hotel, Keighley. "Hydraulic Transmission Applied to Machine Tools," by Mr. C. L. Forbes. 7.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—The Engineers' Club, Albert-square, Manchester. "Cost Control in the Engineering Industries," by Mr. H. Wilmot. 7.15 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—In the Lecture Theatre of the Mining Institute, Newcastle-on-Tyne. "The Prevention and Insulation of Noise," by Dr. E. G. Richardson. 6 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS: GRADUATES SECTION.—Armstrong College, Newcastle-upon-Tyne. "The Trend of Modern Power Station Design, with Particular Reference to Prime Movers," by Mr. J. H. L. Tucker. 7 p.m. This is a Joint Meeting with the Students' Section of the Institution of Electrical Engineers.

RAILWAY CLUB.—Royal Scottish Corporation Hall, Fetter-lane, London, E.C. 4. Annual General Meeting, Presidential Address. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Petroleum," by Sir John Cadman. 9 p.m.

MONDAY, FEBRUARY 15TH.

BRADFORD ENGINEERING SOCIETY.—Technical College, Bradford. "Pumps, Ancient and Modern," by Captain E. H. Marsh. 7.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C. 2. "Workshop Practice in Automobile Engineering," by Sir Herbert Austin, K.B.E. 7.30 p.m.

INSTITUTION OF SANITARY ENGINEERS.—Denison House, 296, Vauxhall Bridge-road, Victoria, S.W. 1. "Agreements for Personal Services," discussion to be opened by Mr. A. J. Martin. 7 p.m.

WOLVERHAMPTON AND DISTRICT ENGINEERING SOCIETY.—The Victoria Hotel, Wolverhampton. "Beet Sugar Manufacture," by Dipl. Ing. Karl Hampel. 7.30 p.m.

TUESDAY, FEBRUARY 16TH.

INSTITUTE OF INDUSTRIAL ADMINISTRATION.—In the Lecture Hall, Institute of Hygiene, 28, Portland-place, W. 1. "Elimination of Waste in Industry," by Mr. E. S. Byng. 6.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Engineering Club, Queen-street, Wolverhampton. "The Possibilities of the Unorthodox," by Mr. Maurice Platt. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: NORTH MIDLAND STUDENTS' SECTION.—Hotel Metropole, Leeds. Address by Mr. R. G. Ward. 7.15 p.m.

INSTITUTION OF WELDING ENGINEERS: NORTH-WESTERN BRANCH.—The College of Technology, Manchester. "Nickel Alloys, with Special Reference to Welding," by Mr. J. McNeil. 7.30 p.m.

OLD CENTRALIANS.—Devereux Restaurant, Devereux-court, Strand, W.C. 2. Monthly Luncheon. 1 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. "Crystal Analysis," by Sir William Bragg, F.R.S. 5.15 p.m.

WEDNESDAY, FEBRUARY 17TH.

INSTITUTE OF FUEL.—(This meeting has been postponed from February 10th.) Chemical Society's Rooms, Burlington House, Piccadilly, London, W. 1. "The Properties of Coals as Controlled by their Composition," by Professor George Hickling. 6 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, S.W. 1. Informal Meeting. Discussion, "The Cable as a Medium for Haulage," by Mr. W. Forster Brown. 6 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Bolbec Hall, Newcastle-upon-Tyne. Graduate Section meeting. "Elementary Jobbing Foundry Practice," by Mr. L. H. W. Wright. 7.15 p.m.

ROYAL METEOROLOGICAL SOCIETY.—49, Cromwell-road, South Kensington, S.W. 7. Meeting at 5 p.m.

ROYAL MICROSCOPICAL SOCIETY.—B.M.A. House, Tavistock-square, W.C. 1. Meeting at 5.30 p.m.

THURSDAY, FEBRUARY 18TH.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Chamber of Commerce, New-street, Birmingham. "Main Road Public Lighting," by Mr. C. Cameron Kirby. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. "Commercial Cooking by Electricity," by Dr. T. Settle. 6 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS: TEES-SIDE BRANCH.—In the Cleveland Scientific and Technical Institution, Corporation-road, Middlesbrough. "Bridge Building," by Mr. A. Brown. 7.30 p.m.

FRIDAY, FEBRUARY 19TH.

ILLUMINATING ENGINEERING SOCIETY.—At the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. Discussion on "Lighting of Churches and Cathedrals." 7.15 p.m.

INSTITUTE OF FUEL.—At the Engineers' Club, 17, Albert-square, Manchester. "The Maintenance of Uniformity in Industrial Fuels," by Dr. A. C. Dunningham. 7 p.m.

INSTITUTION OF CHEMICAL ENGINEERS.—Hotel Victoria, Northumberland-avenue, London, W.C. 2. Annual Corporate Meeting; Presentation of Medals, 11 a.m.; Presidential Address, "Control of Industry," by Mr. W. A. S. Calder, 12 noon; "Thermal Insulation," by Dr. Ezer Griffiths, F.R.S., 2.15 p.m.; Annual Dinner, 7 for 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, S.W. 1. Annual general meeting. The annual report of the Council will be presented; annual election of Council. Papers for discussion, "Testing of Materials for Service in High-temperature Steam Plant," by Mr. R. W. Bailey and Mr. A. M. Roberts; and "An Accelerated Test for the Determination of the Limiting Creep Stress of Metals," by Mr. W. Barr and Mr. W. E. Bardgett. 5.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "The Ventilation and Cooling of Turbo-alternators," by Mr. D. MacFarlane. 7.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Midland Hotel, Manchester. Annual dinner. 6.45 p.m. for 7.15 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Shifting Sands," by Mr. C. F. Jenkin. 9 p.m.

SATURDAY, FEBRUARY 20TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS: SOUTH-EASTERN DISTRICT MEETING.—Assemble at Vestry Hall, London-road, Mitcham. 11.30 a.m.

MONDAY, FEBRUARY 22ND.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W. 1. Graduates' Section. "Potential Applications of Pulverised Fuels," by Mr. H. Heywood. 6.45 p.m.

MONDAY TO SATURDAY, FEBRUARY 22ND TO MARCH 5TH.

BRITISH INDUSTRIES FAIR, 1932.—Castle Bromwich, Birmingham, to March 4th, 1932; Olympia, London, to March 3rd, 1932; White City, to March 5th, 1932.

WEDNESDAY, FEBRUARY 24TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Engineers' Club, Albert-square, Manchester. "The Possibilities of the Unorthodox," by Mr. Maurice Platt. 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: LONDON STUDENTS' SECTION.—Visit to Venner Time Switches, Ltd., Raynes Park, 3 p.m. Annual Dinner at the Florence Restaurant, Rupert-street, W. 1. 7.15 for 7.30 p.m.

INSTITUTION OF WELDING ENGINEERS.—At the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, London, S.W. 1. The name of the winner of the Operative Welders' Prize Competition, 1931, will be declared, followed by the awarding of the Prize and Gold Medal to the winner and a Silver Medal and Certificates to those whose papers are highly commended. The winner will then read his paper "Welding and Cutting on Railways and Tramways," which will be illustrated by lantern slides. 7.45 p.m.

SOCIETY OF GLASS TECHNOLOGY.—Joint Meeting with the Ceramic Society, Sheffield. Visit to Department of Refractory Materials, St. George's-square. 9.15 to 10.45 a.m. In the Applied Science Department, The University, St. George's-square, Sheffield. "The Strength of Materials as Affected by Discontinuities and Surface Conditions," by Professor F. C. Lea; "The Tensile Strength of Glass," by Mr. E. J. Gooding; 11 a.m. "The Crystal Structure of Sillimanite and Related Materials," by Dr. W. H. Taylor; "Studies of Clay Mixtures for Glass Melting Pots: Part IV., The Corrosion-resisting Properties," by Dr. J. H. Partridge, Mr. G. F. Adams and Mr. J. R. Lait; 2.30 p.m.

THURSDAY, FEBRUARY 25TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS: SOUTHERN DISTRICT MEETING.—Assemble at Guildhall, Abingdon, at 11 a.m.

FRIDAY, FEBRUARY 26TH.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—Trocadero Restaurant, Shaftesbury-avenue, London, W. 1. Annual Dinner. 6.30 for 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Recent Applications of the Ternary Alloys of Lead," by Mr. Kenneth Gray. 7.30 p.m.

MONDAY, FEBRUARY 29TH.

ENGINEERS' GERMAN CIRCLE (DEUTSCHER INGENIEURZIRKEL).—At the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. "Leistungen der deutschen Technik 1931" ("German Technical Accomplishments in 1931"). Illustrated with lantern slides, by Herr Oberingenieur Carl Derschow. 6 p.m.

INSTITUTE OF METALS.—Official visit to British Industries Fair, Castle Bromwich, Birmingham.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Discussion on "The Standardisation of the Frequency of Electricity Supply in Paris," opened by Mr. P. Rieunier, who will exhibit a cinematograph film. Joint meeting with the British Section of the Société des Ingénieurs Civils de France. 7.15 p.m.

TUESDAY, MARCH 1ST.

CHEMICAL ENGINEERING GROUP.—Caxton Hall, Westminster, S.W. 1. "Some Problems Connected with High-speed Compression-ignition Engine Developments," by Mr. C. B. Dicksee Joint General Meeting with ten other societies. 7.45 p.m.

WEDNESDAY, MARCH 2ND.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Queen's Hotel, Birmingham. "The Possibilities of the Unorthodox," by Mr. Maurice Platt. 7.30 p.m.

NEWCOMEN SOCIETY.—At the British Industries Fair, Castle Bromwich, in the New Committee Room, near the Royal Room, extreme east of building. "The Early History of the Magnet," by Dr. J. B. Kramer. 4.30 p.m.

FRIDAY, MARCH 4TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W. 1. Informal meeting. Discussion, "Industrial and Commercial Waste," to be introduced by Mr. J. L. Hodgson. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "The Preparation of Commercial Copper from its Ores," by Mr. T. J. Taplin. 7.30 p.m.

MONDAY, MARCH 7TH.

WOLVERHAMPTON AND DISTRICT ENGINEERING SOCIETY.—The Victoria Hotel, Wolverhampton. "Steam Generation in Factories," by Mr. H. E. Partridge. 7.30 p.m.

WEDNESDAY, MARCH 9TH.

INSTITUTE OF METALS.—Trocadero Restaurant, Piccadilly-circus, W. 1. Annual dinner and dance. 7 p.m.

WEDNESDAY AND THURSDAY, MARCH 9TH AND 10TH.

INSTITUTE OF METALS.—In the Hall of the Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Twenty-fourth annual general meeting. Reading and discussion of papers. For programme see page 137.

MONDAY, MARCH 14TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W. 1. Graduates' Section. Annual Lecture, "The Strength and Behaviour of Steels at High Temperatures," by Dr. W. H. Hatfield. 6.45 p.m.

WEDNESDAY, MARCH 16TH.

INSTITUTION OF NAVAL ARCHITECTS.—Grand Hall, Connaught Rooms, Great Queen-street, Kingsway, London, W.C. 2. Annual Dinner. 7.30 p.m.

WEDNESDAY TO FRIDAY, MARCH 16TH, 17TH AND 18TH.

INSTITUTION OF NAVAL ARCHITECTS.—In the Lecture Hall, Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Seventy-third Annual Meeting.

CONTRACTS.

MIRRLEES, BICKERTON AND DAY, Ltd., of 7, Grosvenor-gardens, Westminster, S.W. 1, and Stockport, have recently received from seventeen separate customers in this country and abroad orders for a total of twenty-five heavy-oil engines of either the "Mirrlees-Diesel," "Mirrlees-Simplex," or "Mirrlees-Ricardo" types, having an aggregate horse-power of upwards of 5200.

THE GREAT WESTERN RAILWAY announces that the following contracts, totalling £50,000, have been entered into:—(*a*) Supply and erection of five electric level-luffing jib cranes at Weymouth Harbour, Stothert and Pitt, Ltd., Bath; (*b*) construction of a new cartage office at Paddington Goods Office, Wm. Walker-dine, Ltd., London; (*c*) sinking bore-hole and supply and erection of an electrically driven bore-hole pump at Hockley, Tangyes Ltd., Birmingham; (*d*) supply of steel girders and other steel and ironwork, Patent Shaft and Axletree Company, Ltd., Wednesbury; (*e*) extension to roof covering over No. 1 platform at Paddington Passenger Station, Archibald D. Dawnay and Sons, Ltd., London; (*f*) eight Douglas platform trucks, Douglas Motors, Ltd., Bristol; (*g*) supply and installation of a single-channel carrier telephone system between Swindon and Bristol, Standard Telephones and Cables, Ltd., London; (*h*) supply and erection of roof sheeting at the boiler-house, Stafford-road Works, Wolverhampton, Wolverhampton Corrugated Iron Company, Ltd., Ellesmere Port; (*i*) supply and erection of one 10-ton overhead electric travelling crane for Stafford-road Works, Wolverhampton, Vaughan Crane Company, Ltd., Wolverhampton; (*j*) alterations and additions to steel gantry to Hoist No. 4 at Barry Docks, Archibald D. Dawnay and Sons, Ltd.; (*k*) provision of two batteries and one switchboard at Cardiff Queen-street Station, Britannia Batteries, Ltd., London; (*l*) construction of a circular chimney at the new erecting shops at Stafford-road, Wolverhampton, P. C. Richardson and Co., Ltd., Middlesbrough; (*m*) supply and erection of one 30 cwt. electric parcels lift at Bishop's-road Parcels Office, Paddington, H. O. Strong and Sons, Ltd., Bristol; (*n*) supply of steel castings for roller paths for the South Dock Outer Gates at Swansea Docks, F. H. Lloyd and Co., Ltd., Wednesbury; and (*o*) new Parcels Depôt at Cardiff General Station, Holcombe and Sons, Ltd., Cardiff.

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